Title: Critter Constructions

Brief Overview:

This Concept Development Unit focuses on constructions in Geometry. This unit will work best with students who are sitting in cooperative learning groups. The CDU will begin a pre–assessment evaluating the students' knowledge of essential Geometry definitions. The unit will then introduce the basic geometric constructions using patty paper that will lead the students to be able to find the points of concurrency. The unit has a project–based assessments consisting of three parts: individual display, individual oral presentation and group constructed responses to application questions.

NCTM Content Standard/National Science Education Standard:

- Draw and construct representations of two–dimensional geometric objects using a variety of tools
- Use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest
- Analyze properties and determine attributes of two– dimensional objects
- Explore relationships among classes of two–dimensional geometric objects, make and test conjectures about them, and solve problems involving them

Grade/Level:

Grades 9 – 12; Secondary Geometry

Duration/Length:

Three 90 – minute class periods

Student Outcomes:

Students will:

- Develop a working definition of parallel lines, perpendicular lines, perpendicular bisector, midpoint, altitude angle bisector, incenter, circumcenter, centroid
- Construct parallel lines, perpendicular lines, perpendicular bisector, midpoint, altitude angle bisector, incenter, circumcenter, centroid
- Apply their knowledge of constructions to solve real–world problems

Materials and Resources:

- Patty Paper
- Ruler
- Pencil

- Compass
- Pre–cut card stock triangle (one for each student)
- Envelope with Envelope cards
- Copies of worksheets
    - Critter Constructions Assessment Rubric
    - Basic Constructions Pre–Assessment
    - Iguana and Caterpillar Exploration
    - Atkinsons and Georgetown Hoyas
    - Isabel and Carl's Coach Player
    - Assessment to Basic Construction
    - Isabel and Carl's Roundtable
    - Application of Incenter and Circumcenter
    - Group Application Questions
    - Matching Labels

Development/Procedures:

Day 1

- Pre–assessment
  Divide the class into cooperative learning groups, and give each student a copy "Basic Constructions" pre–Assessment worksheet. Instruct each group to discuss the definition of each vocabulary word and come to a consensus on a working definition. Have each student write this definition on his worksheet. Invite groups up to present a definition until all definitions are discussed... Allow the class to approve or modify each definition. Use the class discussion to have the, students correct their working definitions.

- Exploration:
  Distribute patty paper and "Iguana and Caterpillar Exploration" worksheet. Allow time for the students to explore different methods for constructing a midpoint, perpendicular bisector and an angle bisector. Circulate to answer questions and confirm correct constructions. Emphasize "Time to Play" on the first page, allowing time for the students to explore the patty paper and discover the correct folds through trial and error.

- Explanation:
  Model and directly instruct the construction of parallel lines and perpendicular lines using patty paper and the Construction of Carl's Spine and the Construction of Isabel's Tongue components of the "Iguana and Caterpillar Exploration" worksheet.

- Application:

Assign the "Atkinsons and Georgetown Hoyas" worksheet for the students to practice and apply the patty paper constructions of perpendicular bisectors and angle bisectors. Allow students to work with their group members.

- Differentiation:
  - Reteach:
    Divide the class into pairs and give each pair a copy of the worksheet, "Isabel and Carl's Coach Player". Have the students choose who will be 'constructor one' and 'constructor two'. Instruct the students to take turns coaching the other student on how to perform the specified construction. Set the rule that the student is only allowed to perform the steps stated by the coach, but can ask questions for clarification.

  - Enrich:
    Refer to the 'Reteach' section above.

- Assessment:
  Assess student mastery of the patty paper constructions for midpoint, perpendicular bisector, angle bisector and parallel lines with "Assessment to Basic Construction." Be sure the students attach the patty paper to the assessment paper when they submit their work.

Day 2

- Exploration:
  Divide the class into groups of four, and have the students will follow the directions for "Isabel's Roundtable Construction" worksheets and "Carl's Roundtable Construction" worksheets. Explain the following rules to the students:
    - Each student in the group receives a different worksheet and follows the directions in box one by drawing a triangle.
    - The papers then get passed one student clockwise.
    - Each student checks the work student one did and then follows the directions in box two.
    - The worksheets and accompanying patty paper are passed one student clockwise.
    - Student three checks the work of student two and follows the directions in box three.
    - This process continues until each student receives his original paper back and writes a conjecture.
    - Then the group should compare and contrast the conjectures based on the right, acute, and obtuse triangles.
    -

- Explanation:

Allow groups time to discuss their conjectures that all three lines meet at a common point. Elicit volunteers in each group to present their conjectures to the other groups. Introduce vocabulary words for point of concurrency, incenter and circumcenter.

- Application:
  Provide additional patty paper and assign the "Application of Incenter and Circumcenter" worksheet to practice and apply the constructions of incenters and circumcenters. Permit the students to work with their group members.

- Differentiation: Use the assessment results from Day 1 to group students for today's activity. Each group can consist of one student who is strong on the constructions, one student who is weaker with the construction and two students with moderate construction skills. After the roundtable activity and class discussion on the new vocabulary, hand out Boss/Secretary Incenter worksheet and Boss/Secretary Circumcenter worksheet. Distribute compasses to the students in order to draw the various circles using the circumcenter and in the incenter.
  - Reteach: .Students get additional practice constructing the incenter and circumcenter of a triangle.

  - Enrich: Students with stronger understandings on construction can become the leader in today's group activity. They will have to verbalize the construction steps when working with the other members in their group. After each construction, the stronger students can explore their construction justifications with a compass.

- Assessment:
  - Distribute the "Critter Constructions Assessment Rubric" and explain the expectations for the unit project. The assessment consists of three parts: a display, an oral presentation, and group assessment. The individual display will consist of the seven constructions, as identified on the rubric sheet, with an explanation of the procedure and purpose for each construction. The teacher will randomly choose two of these constructions for the student to present orally to the teacher. Students will also work with their group members to answer four out of five constructed response questions. Allow the students to begin working on individual display and continue to work on it for homework.

Day 3

- Exploration:
  The teacher will cut different triangles from card stock or index cards prior to the start of class. Direct the students to balance the triangle on the tip of

their pencil without making any holes or creases in the triangle. Challenge the students to find the balancing point of the triangle, and mark this point on the triangle. Hand out patty paper and have the students copy the triangle onto patty paper. Instruct the students to fold the midpoint of each side. Then, the students will use a straightedge to connect each midpoint to the vertex opposite the side containing the midpoint, forming the medians. Students will make a conjecture about their observations on this exploration and discuss their conjectures with their group.

- Explanation:
  Elicit volunteers to share their conjectures to the class (three lines are concurrent). Introduce the words: median, centroid and center of gravity. Develop with the students working definitions for these vocabulary words. Explain the definition and construction of an altitude using patty paper. Add a working definition for this vocabulary word to the students' notes.

- Application:
  - Regroup the students by using the Matching Labels activity. Put vocabulary words and pictures on separate index cards. Each student picks an index card and finds his match by putting word and picture together with another student. There are two matching labels (altitude) that have not yet been discussed. These two students will be partners by default. The teacher can discuss the definition of an altitude, which will lead into the next bullet.

  - Have the students re–use the back of the card stock triangle from the exploration. Instruct the students to construct the three altitudes of this triangle and make a conjecture that the lines are concurrent. Tell the students that the point of concurrency for three altitudes is called an orthocenter.

- Differentiation:
  - Reteach:
    Using the triangles from the Median activity, provide rulers and have the students measure segments in the triangle and find the area of each triangle. Students should write conjectures on their findings. Circulate and provide support/guiding questions for the students in need of guidance.

  - Enrich:
    Using the triangles from the Median activity, provide rulers and have the students measure the segments in the triangle and find the area of each triangle. Students should write conjectures on their findings. Challenge the higher–level students to investigate the relationships on their own concluding that all six triangles formed

by the 3 medians have equal area (medians spread the mass of the triangle evenly) and each median is divided into two sections (one segment twice as long as the other segment).

Summative Assessment:

The summative assessment for constructions will be 100 points and consist of three parts:

- an individual display 50 points
- an oral presentation and 18 points
- group responses to construction application questions 32 points

The individual display will consist of the seven constructions listed on the project–based assessment rubric with an explanation of the procedure and purpose *for each construction.* For the oral presentation, the student will randomly choose two constructions from two hats to construct and present verbally to the teacher. The first hat will contain constructions for midpoint, perpendicular bisector, angle bisector, and perpendicular line through a point. The second hat will contain parallel lines, incenter and circumcenter. Simultaneously to the oral presentations, students will work with their group members to answer four out of five constructed response questions. Refer to the "Critter Constructions Assessment Rubric" for further details of the summative assessment.

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Critter Constructions Name_____
Assessment Rubric

The summative assessment for constructions will be 100 points and consist of three parts:

Part	Points
Individual display	50
Oral presentation	18
Group responses to construction application questions	32

The individual display will consist of the seven constructions, as identified on the rubric sheet, with an explanation of the procedure and purpose *for each construction.* You will randomly choose two of these constructions to present orally to the teacher. You will also work with your group members to answer four out of five constructed response questions.

Due Dates:

Part	Date Due:
Individual display	
Oral presentation	
Group responses to construction application questions	

Individual Display Name: _____

Points	Construction:	Procedure	Purpose
Full Credit	Shows all necessary components of the construction	Demonstrates full knowledge of construction vocabulary terms by correctly describing the construction process	Fully describes an accurate and appropriate use of the construction with example
Partial Credit	Shows most necessary components of the construction	Demonstrates some knowledge of construction vocabulary terms by partially describing the construction process	Incompletely describes the process by fully describing an accurate and appropriate use of the construction OR provides a correct use of the construction
Minimal Credit	Shows few necessary components of the construction	Demonstrates little knowledge of construction vocabulary terms by incompletely describing the construction process	Provides little evidence of the purpose of the construction
No Credit	Shows an incorrect or missing construction	Demonstrates no knowledge of construction vocabulary terms by incorrectly describing the construction process	Provides no evidence of the purpose of the construction

Note: The components of a construction are the creases and labels.

Required Construction	Points Earned	Total Points	Teacher Comments:
Midpoint		5	
Perpendicular bisector		5	
Angle bisector		6	
Parallel lines		7	
Perpendicular line through a point		7	
Incenter		10	
Circumcenter		10	
TOTAL SCORE:		**50**	

Oral Presentation Name: _____

Points	Construction:	Procedure	Purpose
Full Credit	Shows all necessary components of the construction	Demonstrates full knowledge of construction vocabulary terms by correctly describing the construction process	Fully describes an accurate and appropriate use of the construction with example
Partial Credit	Shows most necessary components of the construction	Demonstrates some knowledge of construction vocabulary terms by partially describing the construction process	Incompletely describes the process by fully describing an accurate and appropriate use of the construction OR provides a correct use of the construction
Minimal Credit	Shows few necessary components of the construction	Demonstrates little knowledge of construction vocabulary terms by incompletely describing the construction process	Provides little evidence of the purpose of the construction
No Credit	Shows an incorrect or missing construction	Demonstrates no knowledge of construction vocabulary terms by incorrectly describing the construction process	Provides no evidence of the purpose of the construction

Construction Chosen	Points Earned	Total Points	Teacher Comments:
		8	
		10	
TOTAL SCORE:		**18**	

Group Responses to Construction Application Questions (32 points):

4 The response indicates **application** of a reasonable strategy that leads to a correct solution in the context of the problem. The **representations** are correct. The **explanation** and/or **justification** is logically sound, clearly presented, fully developed, supports the solution, and does not contain significant mathematical errors. The response demonstrates a complete understanding and **analysis** of the problem.

3 The response indicates **application** of a reasonable strategy that may or may not lead to a correct solution. The **representations** are essentially correct. The **explanation** and/or **justification** is generally well developed, feasible, and supports the solution. The response demonstrates a clear understanding and **analysis** of the problem.

2 The response indicates an incomplete **application** of a reasonable strategy that may or may not lead to a correct solution. The **representations** are fundamentally correct. The **explanation** and/or **justification** supports the solution and is plausible, although it may not be well developed or complete. The response demonstrates a conceptual understanding and **analysis** of the problem.

1 The response indicates little or no **application** of a reasonable strategy. It may or may not have the correct answer. The **representations** are incomplete or missing. The **explanation** and/or **justification** reveal serious flaws in reasoning. The explanation and/or justification may be incomplete or missing. The response demonstrates a minimal understanding and **analysis** of the problem.

0 The response is completely incorrect or irrelevant. There may be no response, or the response may state, "I don't know."

Explanation refers to the student using the language of mathematics to communicate how the student arrived at the solution.

Justification refers to the student using mathematical principles to support the reasoning used to solve the problem or to demonstrate that the solution is correct. This could include the appropriate definitions, postulates and theorems.

Essentially correct representations may contain a few minor errors such as missing labels, reversed axes, or scales that are not uniform.

Fundamentally correct representations may contain several minor errors such as missing labels, reversed axes, or scales that are not uniform.

http://www.mdk12.org/share/rubrics/hsa/mathematics/pdf/HSA_MathematicsRubricV1.pdf

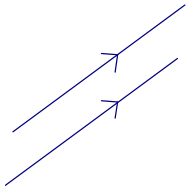
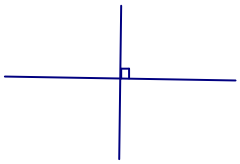
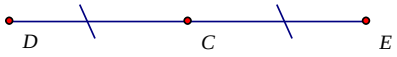
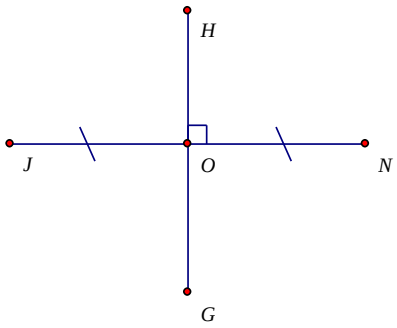
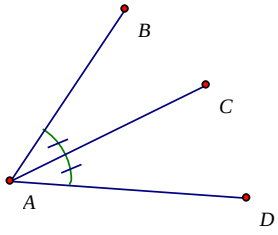
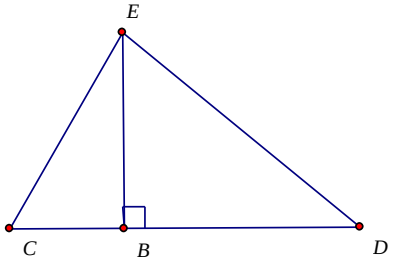
Basic Constructions Name_____
Pre-Assessment

Directions: As a group, discuss the meaning of the following words. Come to a consensus of a working definition and write it on this paper. You may use words and/or pictures in your definitions.

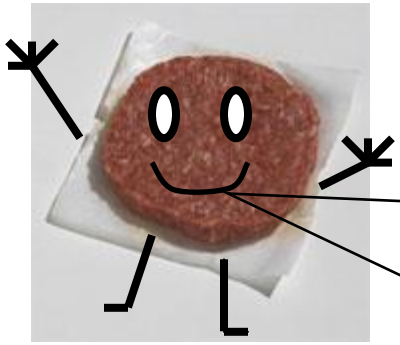
Parallel Lines	**Perpendicular Lines**
Midpoint	**Perpendicular Bisector**
Angle Bisector	**Altitude Of A Triangle**

Basic Constructions Name__ANSWER KEY____
Pre-Assessment

Directions: As a group, discuss the meaning of the following words. Come to a consensus of a working definition and write it on this paper. You may use words and/or pictures in your definitions.

Parallel Lines Lines on the same plane that do not intersect 	**Perpendicular Lines** Lines that intersect to from right angles 
Midpoint The point that divides a segment into two equal segments  ***C*** is the midpoint of $\overline{DE}$	**Perpendicular Bisector** A line or segment that is perpendicular to a segment at its midpoint  $\overline{HG}$ is the perpendicular bisector of $\overline{JN}$
Angle Bisector A ray that divides an angle into two congruent angles  $\overline{AC}$ is the angle bisector of $\angle BAD$	**Altitude Of A Triangle** A segment from a vertex of a triangle perpendicular to the opposite side  ___ $\overline{EB}$ *is the altitude of* ΔCED

Iguana and Caterpillar Exploration Name: _____



Greeting fellow Constructors! I'm Premonition Pete. Unlike those phony bologna crystal balls, I see things through patty paper. You will never again think of a regular hamburger the same way. That's right, math is everywhere! Not only does patty paper keep your beef from freezing together, it allows you to construct and explore!

1. Like Premonition Pete's good pal, SB, Pete too is a little square dude. What does prove about the corners of patty paper?

2. Take time to play! Fold a sheet of patty paper to construct **perpendicular lines**. Explain the steps of the construction. Justify these lines are perpendicular.

3. Fold a sheet of patty paper to construct lines *m* and *n* both perpendicular to line *p*. Write a conjecture about lines *m* and *n*.

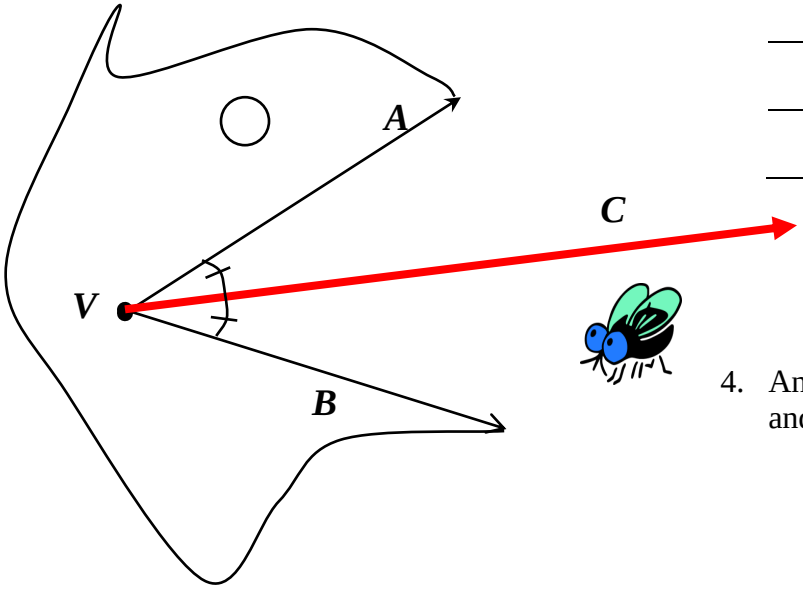
Hello, I'm Isabel the Iguana. I really enjoy a tasty fly snack. My tongue stretches along the middle of my mouth. In the figure below ray VC is my tongue. Ray VC is the **angle bisector** for angle AVC.

3. What geometric figure does Isabel's mouth represent?

_____

_____

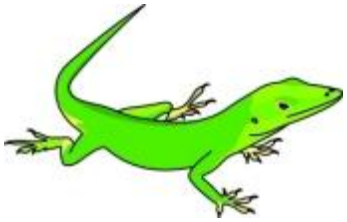
_____



4. Angles are composed of two _____ and one _____.

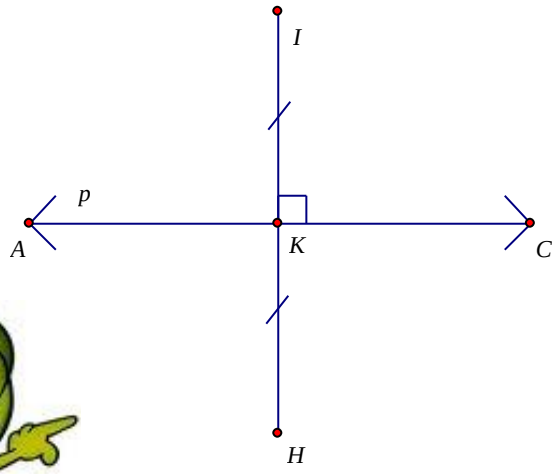
5. Write a geometric statement describing the angles that are congruent, given $\overrightarrow{VC}$ bisects $\angle AVC$.

_____



Any point on the **angle bisector** is equidistant to the rays used to create it.

I am Carl. I am cRaZy!! If you follow my directions to an upside down "T" I will do a split for you. Check out line *p*. Line *p* is the **Perpendicular Bisector** of segment *IH*.



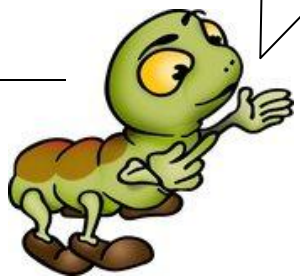
6. Write a geometric statement describing the segments that are congruent, given line *p* bisects $\overline{IH}$.

_____

7. Write a geometric statement describing the relationship between $\overline{IH}$ and $\overleftrightarrow{AC}$.

_____

Any point on the **perpendicular bisector** is equidistant to the endpoints used to create it.



To help you remember: my boots/feet represent _____, since I can match each pair together. My spine represents the _____ _____. Therefore my head which is a specific point on the _____ _____ is equidistant to a pair of _____.

http://www.fotosearch.com/clip–art/caterpillar.html

Construction of Carl's spine.

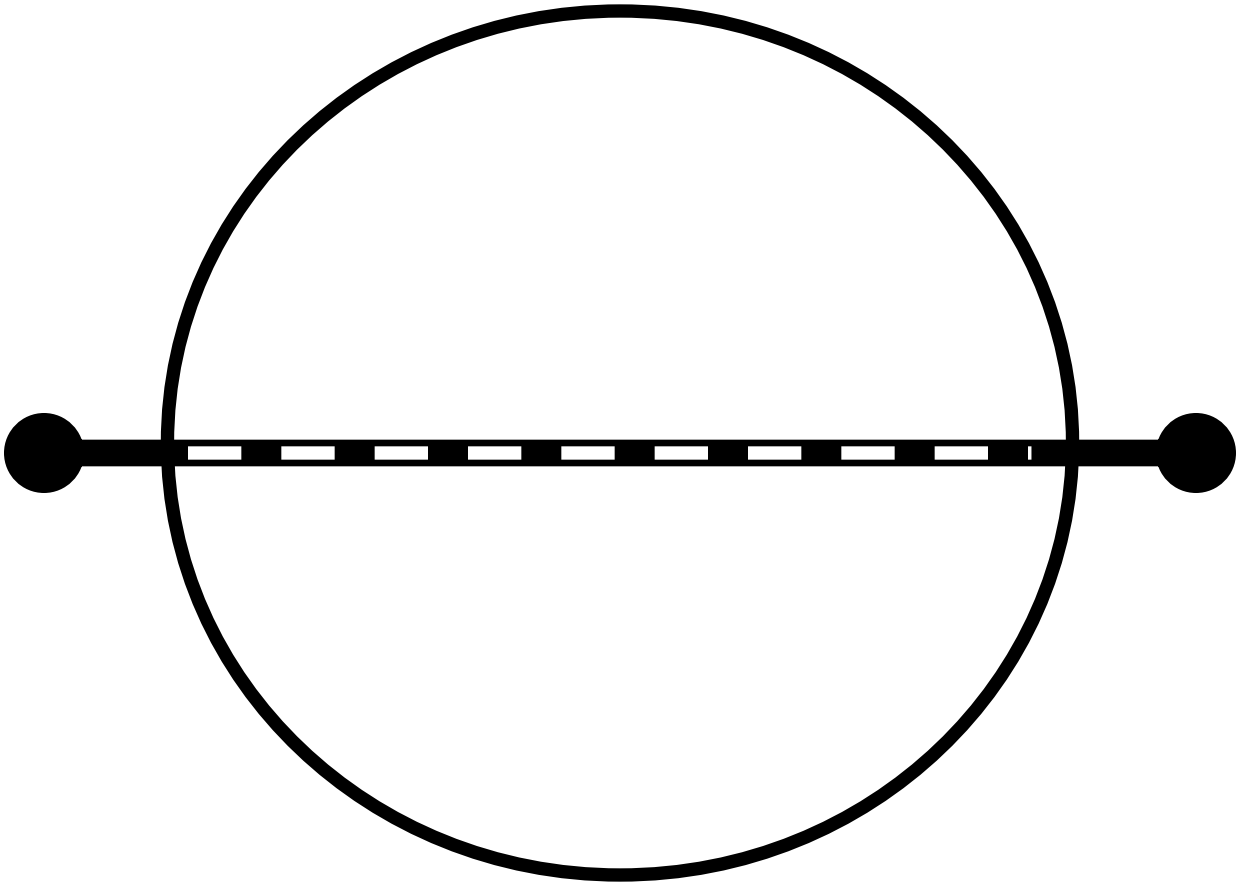
- Carl's spine is spine is equidistant to his feet on each section of his body. It is easy to find because it is a different color than the rest of his skin!
- Construct one section of Carl's spine. Fold the segment so that the two endpoints coincide.
- Crease the paper. This crease is Carl's spine, but mathematically is called the **perpendicular bisector**.
- In addition to an off-color spine, Carl has a birthmark. This birthmark lies directly on his spine. Select a location on the perpendicular bisector to place Carl's birth mark.
- Is Carl's birth mark closer to his left foot or his right foot? Explain.

_____

_____

_____

- Have fun decorating Carl, his spine and his birth mark.
- Label the mathematical parts Carl represents.



Construction of Isabel's Tongue.

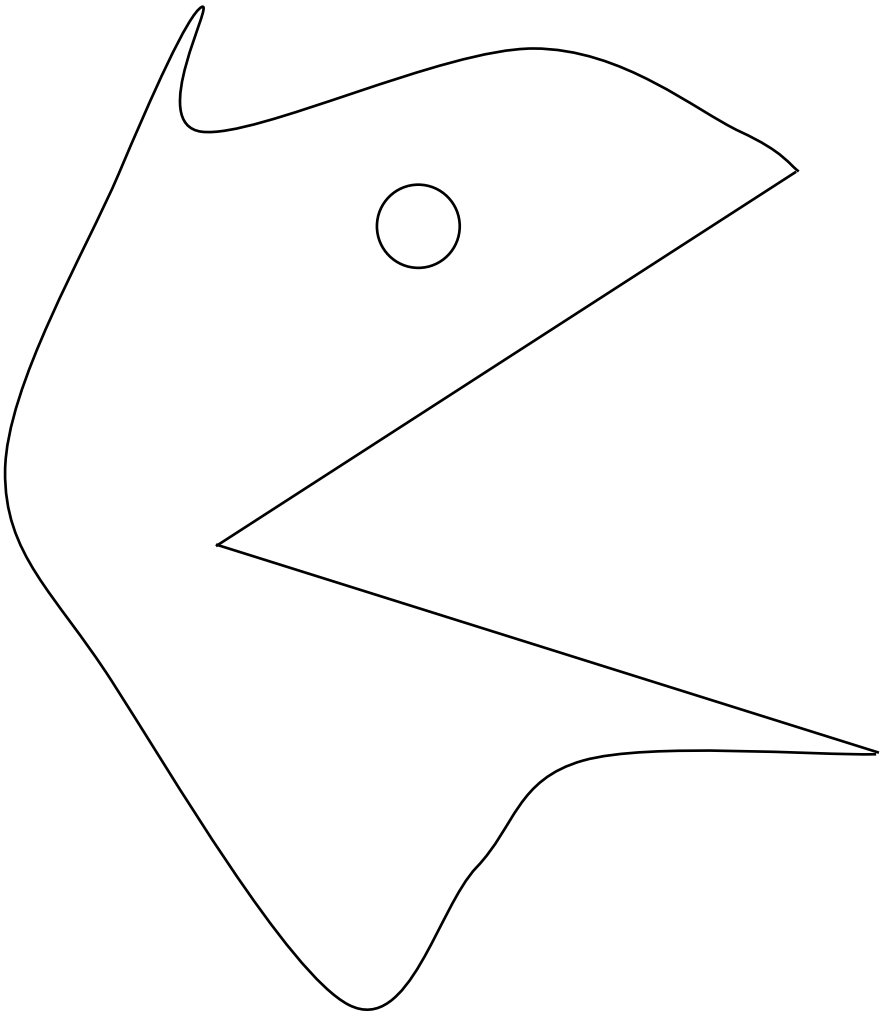
- Isabel's mouth is an angle composed of two rays and one vertex.
- Fold the angle through the vertex so that the two rays coincide.
- Crease the paper. This crease is Isabel's tongue and mathematically called the **angle bisector**.
- Select a location on the angle bisector to place Isabel's lunch. Is her lunch closer to her top teeth or her bottom teeth? Explain.

_____

_____

_____

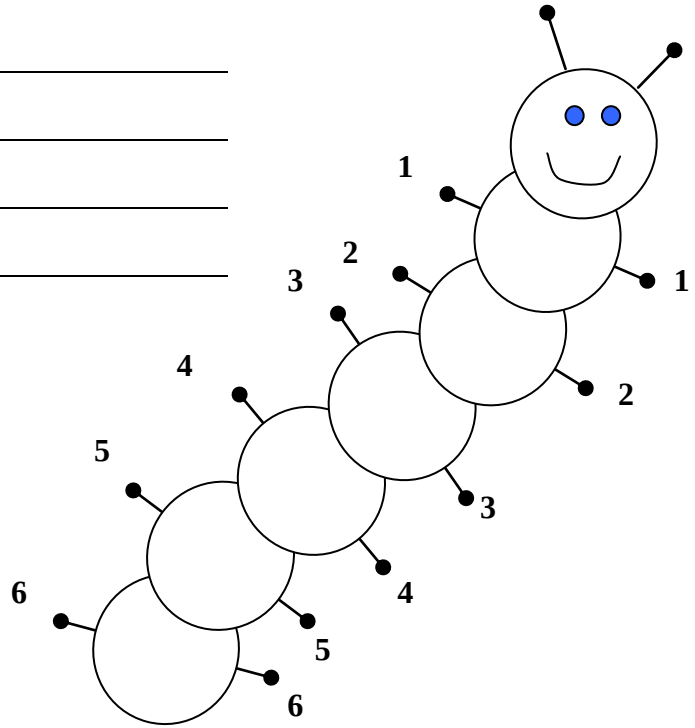
- Have fun decorating Isabel, her tongue and a piece of food that she catches.
- Label the mathematical parts Isabel represents.



Now it is time to Practice with Carl

Show Crazy Carl your construction skills by constructing the six **perpendicular bisectors** for each pair of feet. Starting at the head, follow the perpendicular bisectors moving onto the next one as they intersect, to trace the stripe that runs down his spine.

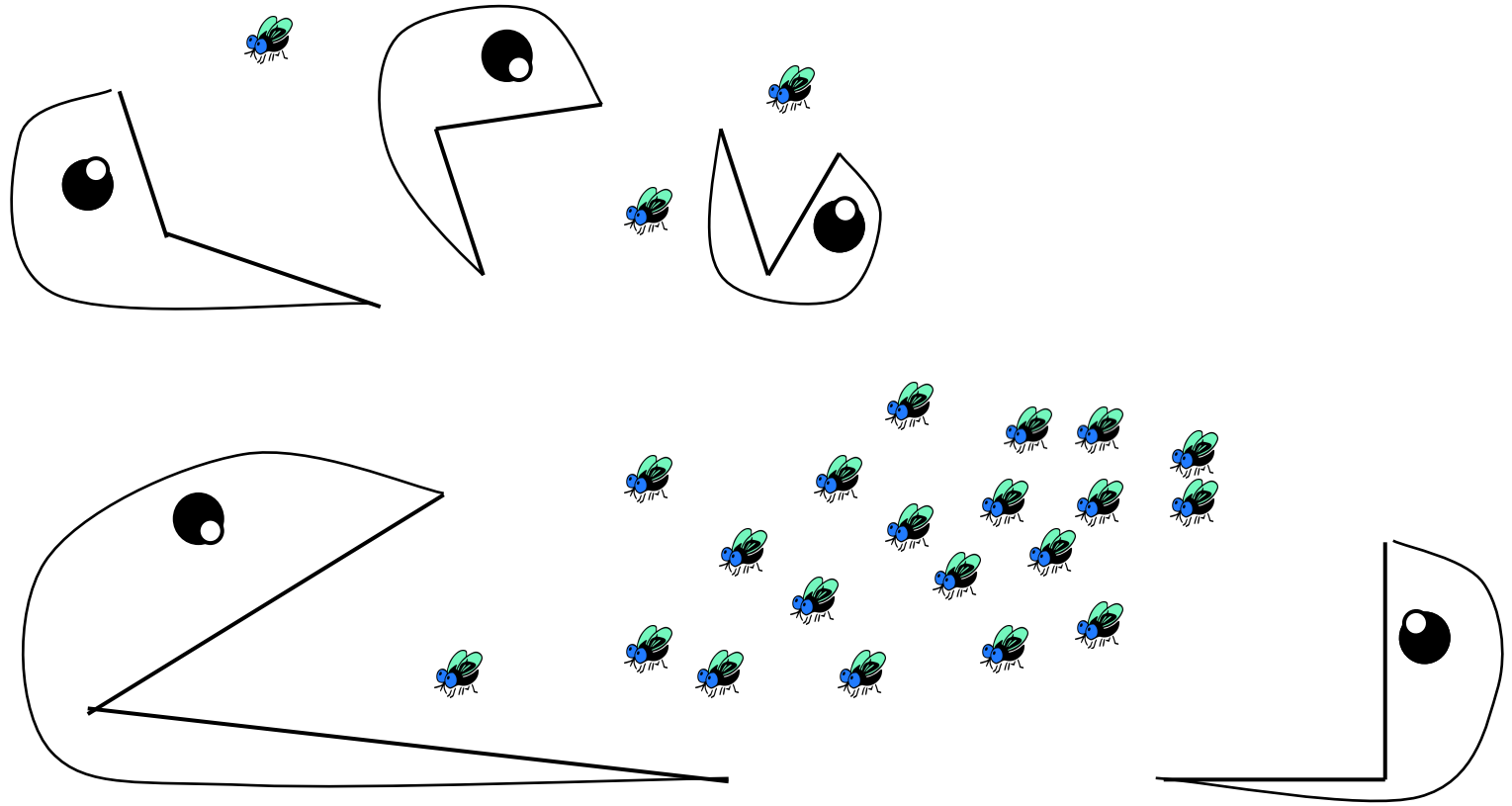
- Did you show appropriate congruent and perpendicular marks in your construction?
- Please draw Carl's tail so its end is equal distance from his last pair of shoes.
- Justify this construction.



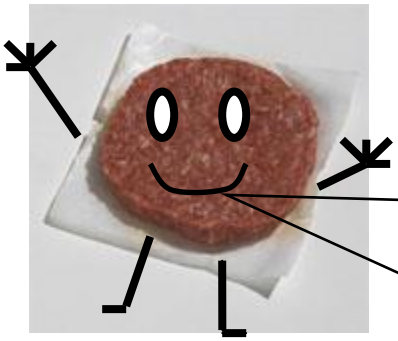
Time to practice with Isabel:

Show Isabel your construction skills by constructing five **angle bisectors**. Isabel will use her tongue five times to catch dinner.

- How many fillies did Isabel eat for supper?_____
- Did you show appropriate congruent marks to finalize your construction?
- What do you know about the placement of the fly with respect to each angle?



Iguana and Caterpillar Exploration Name: __ANSWER KEY___



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1. Like Premonition Pete's good pal, SB, Pete too is a little square dude. What does prove about the corners of patty paper?

The corner of the patty paper is a right angle (90°).

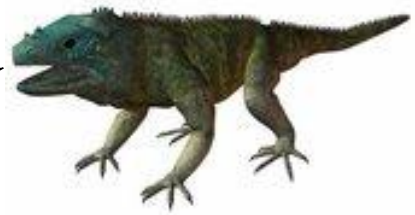
2. Take time to play! Fold a sheet of patty paper to construct **perpendicular lines**. Explain the steps of the construction. Justify these lines are perpendicular.

To construct perpendicular lines, fold a segment. Fold this segment in half so the endpoints touch. A segment measures 180°, and folding it in half cuts the 180° in half, forming 90° angles.

3. Fold a sheet of patty paper to construct lines *m* and *n* both perpendicular to line *p*. Write a conjecture about lines *m* and *n*.

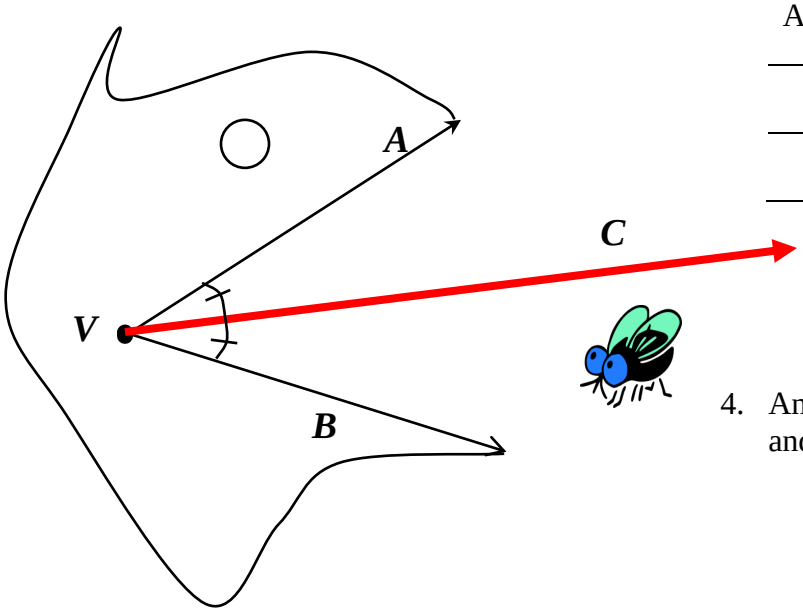
Lines *m* and *n* are parallel.

Hello, I'm Isabel the Iguana. I really enjoy a tasty fly snack. My tongue stretches along the middle of my mouth. In the figure below ray VC is my tongue. Ray VC is the **angle bisector** for angle AVC.



4. What geometric figure does Isabel's mouth represent?

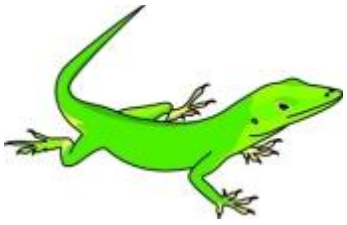
An angle



4. Angles are composed of two __rays___ and one __vertex__.

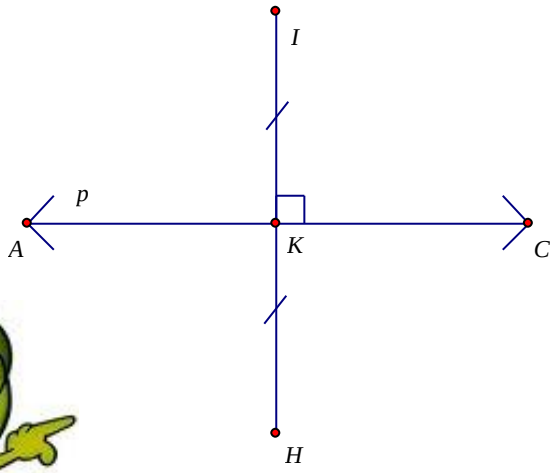
5. Write a geometric statement describing the angles that are congruent, given $\overrightarrow{VC}$ bisects $\angle AVC$.

$\angle BVC \cong \angle AVC$ or $m\angle BVC = m\angle AVC$



Any point on the **angle bisector** is equidistant to the rays used to create it.

I am Carl. I am cRaZy!! If you follow my directions to an upside down "T" I will do a split for you. Check out line *p*. Line *p* is the **Perpendicular Bisector** of segment *IH*.



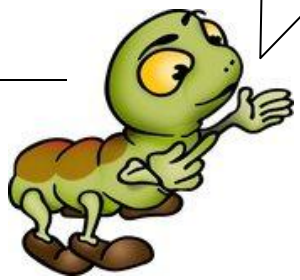
6. Write a geometric statement describing the segments that are congruent, given line *p* bisects $\overline{IH}$.

$\overline{IK} \cong \overline{KH}$ or $m\overline{IK} = m\overline{KH}$

Any point on the **perpendicular bisector** is equidistant to the endpoints used to create it.

7. Write a geometric statement describing the relationship between $\overline{IH}$ and $\overleftrightarrow{AC}$.

$\overline{IH} \perp \overleftrightarrow{AC}$



To help you remember: my boots/feet represent _points_, since I can match each pair together. My spine represents the _perpendicular bisector_. Therefore my head which is a specific point on the __perpendicular bisector is equidistant to a pair of _points_.

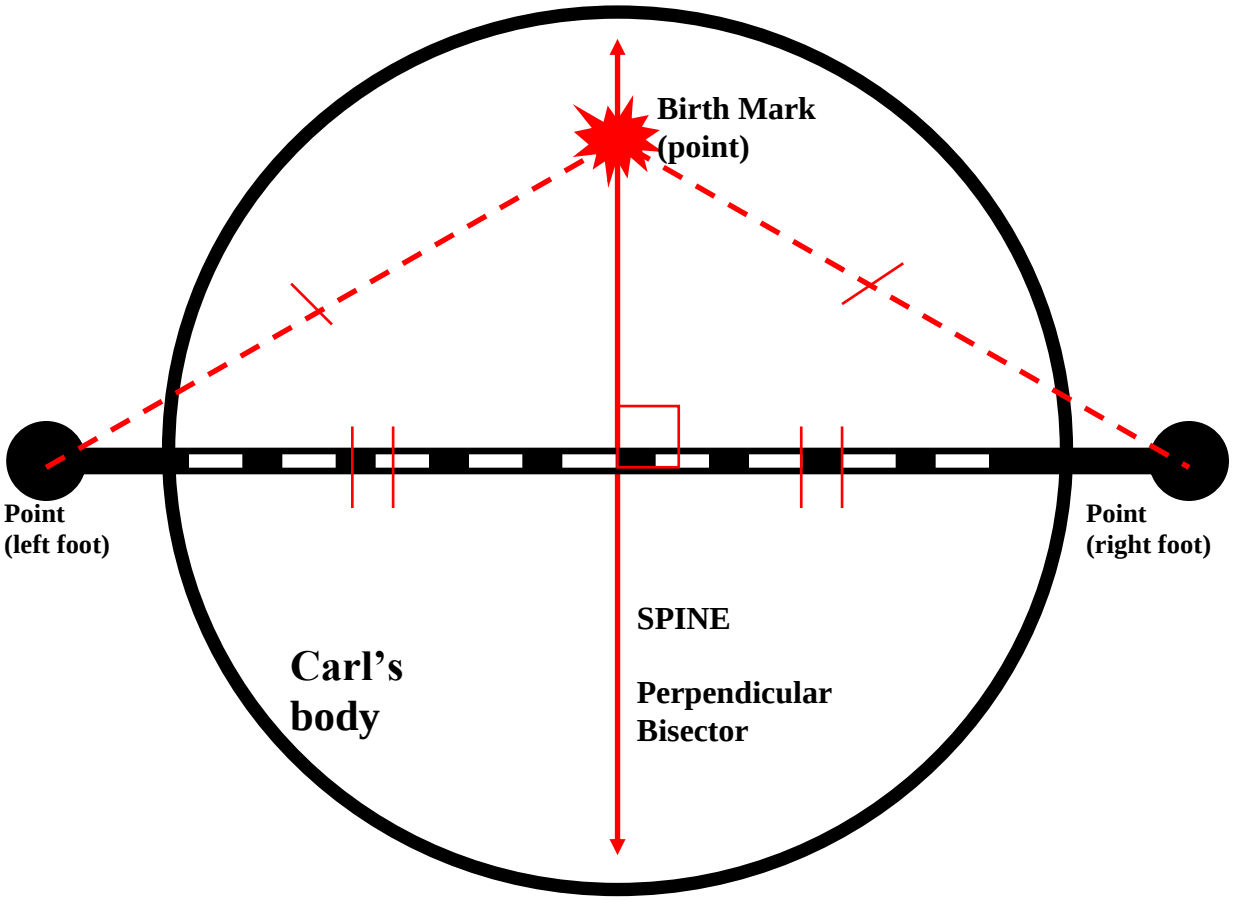
http://www.fotosearch.com/clip–art/caterpillar.html

Construction of Carl's spine.

- Carl's spine is spine is equidistant to his feet on each section of his body. It is easy to find because it is a different color than the rest of his skin!
- Construct one section of Carl's spine. Fold the segment so that the two endpoints coincide.
- Crease the paper. This crease is Carl's spine, but mathematically is called the **perpendicular bisector**.
- In addition to an off-color spine, Carl has a birthmark. This birthmark lies directly on his spine. Select a location on the perpendicular bisector to place Carl's birth mark.
- Is Carl's birth mark closer to his left foot or his right foot? Explain.

All points lying on the perpendicular bisector are equidistant to the endpoints of the segment. Therefore, the birthmark is the same distance from either foot. Drawing an isosceles triangle verifies this, as well as folding the patty paper. (See student constructions as well.)

- Have fun decorating Carl, his spine and his birth mark.
- Label the mathematical parts Carl represents.



Construction of Isabel's Tongue.

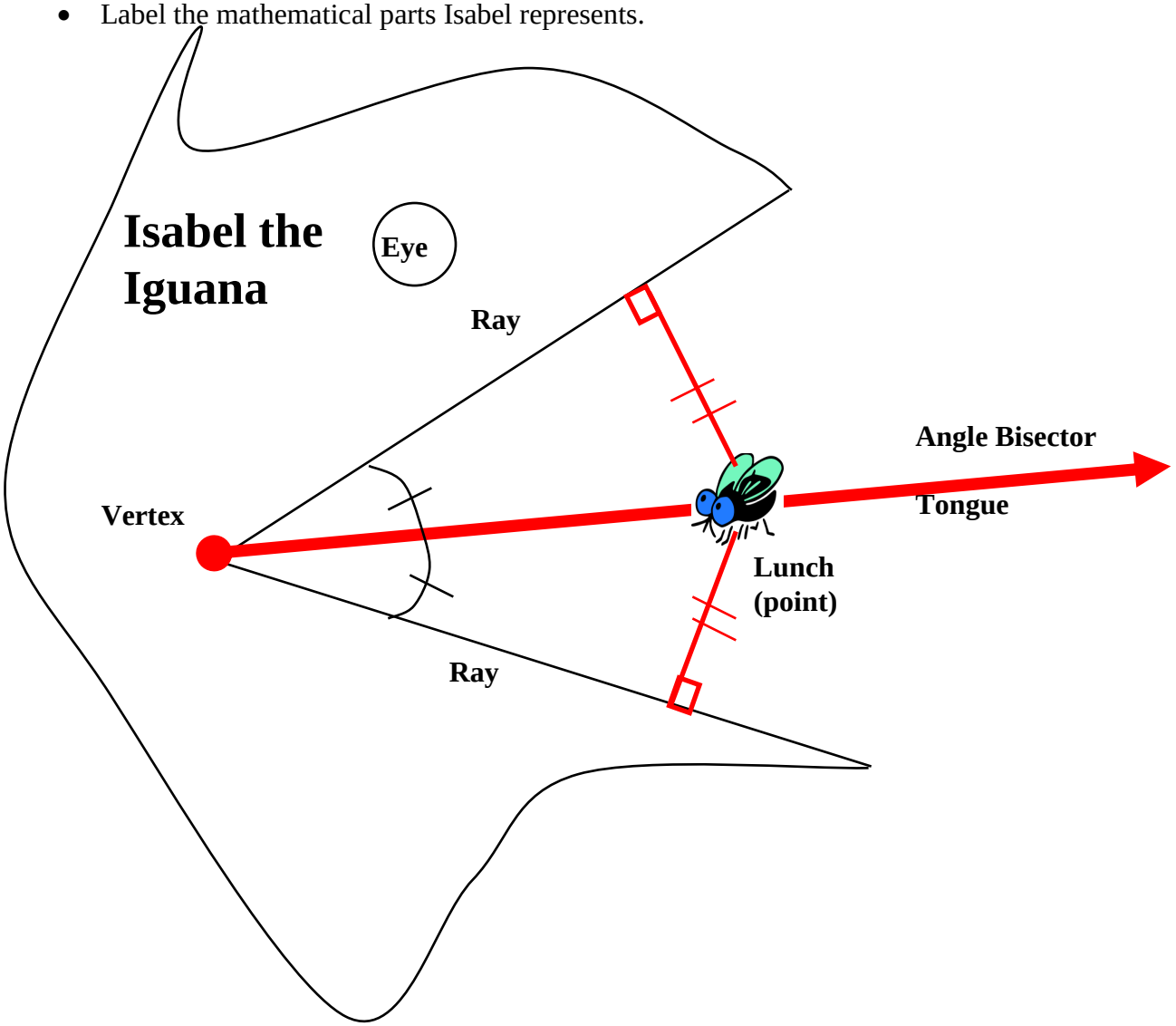
- Isabel's mouth is an angle composed of two rays and one vertex.
- Fold the angle through the vertex so that the two rays coincide.
- Crease the paper. This crease is Isabel's tongue and mathematically called the **angle bisector**.
- Select a location on the angle bisector to place Isabel's lunch. Is her lunch closer to her top teeth or her bottom teeth? Explain.

_____

_____

_____

- Have fun decorating Isabel, her tongue and a piece of food that she catches.
- Label the mathematical parts Isabel represents.

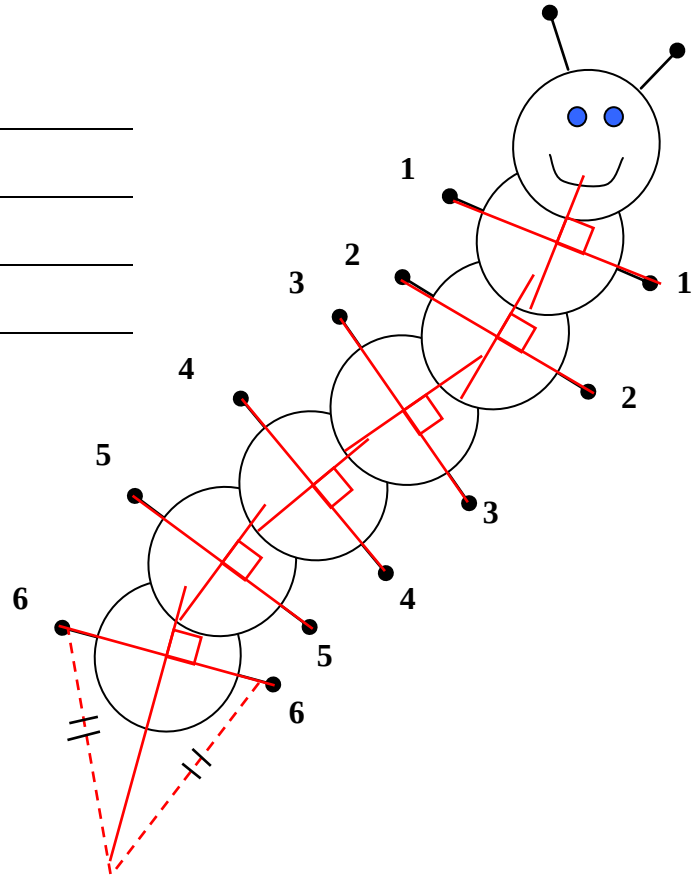


Now it is time to Practice with Carl

Show Crazy Carl your construction skills by constructing the six **perpendicular bisectors** for each pair of feet. Starting at the head, follow the perpendicular bisectors moving onto the next one as they intersect, to trace the stripe that runs down his spine.

- Did you show appropriate congruent and perpendicular marks in your construction?
- Please draw Carl's tail so its end is equal distance from his last pair of shoes.
- Justify this construction.

  See student work.

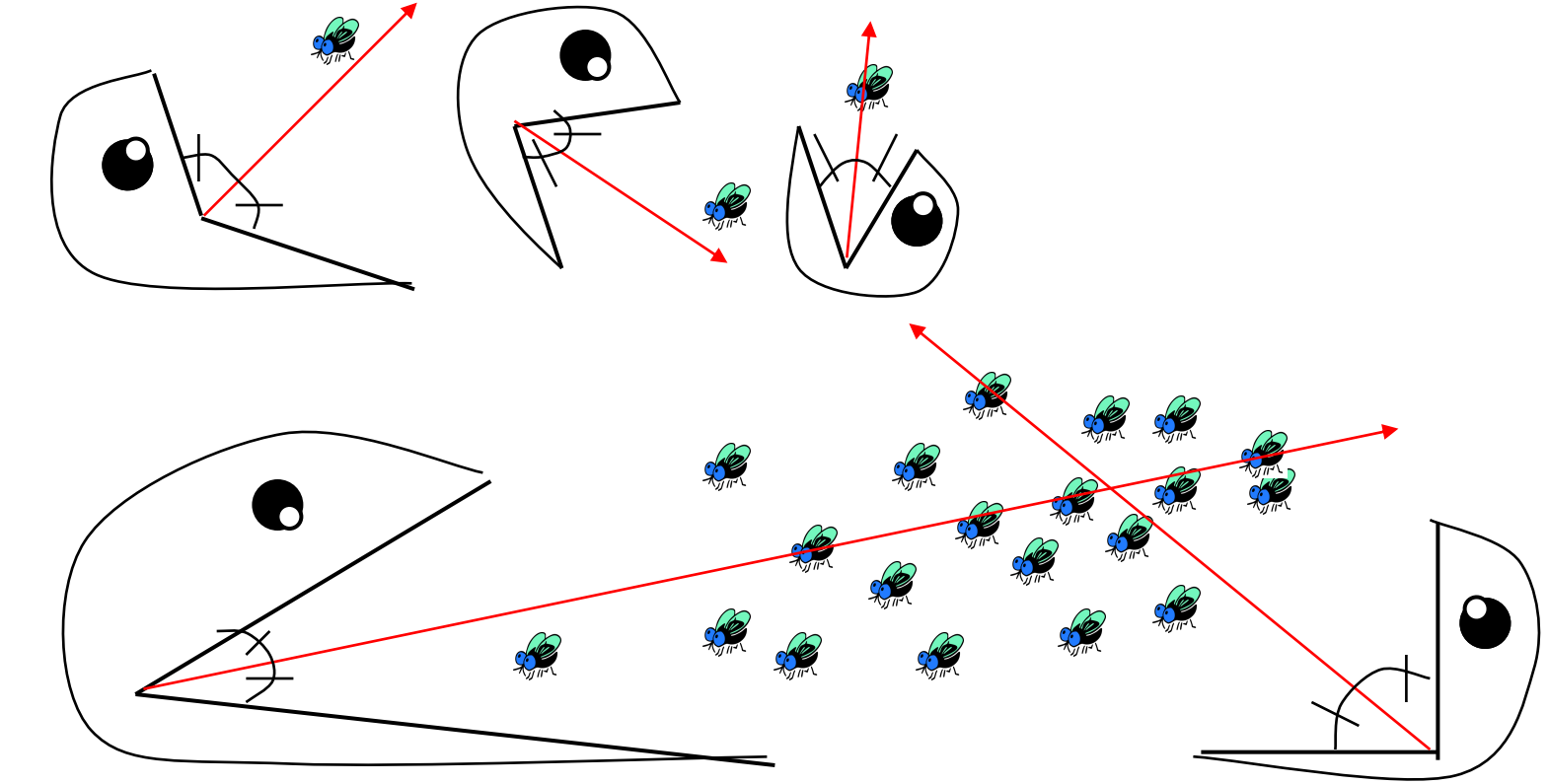


Time to practice with Isabel:

Show Isabel your construction skills by constructing five **angle bisectors**. Isabel will use her tongue five times to catch dinner.

- How many fillies did Isabel eat for supper?__7____
- Did you show appropriate congruent marks to finalize your construction?
- What do you know about the placement of the fly with respect to each angle?

The fly is equidistant to the rays of the each angle.

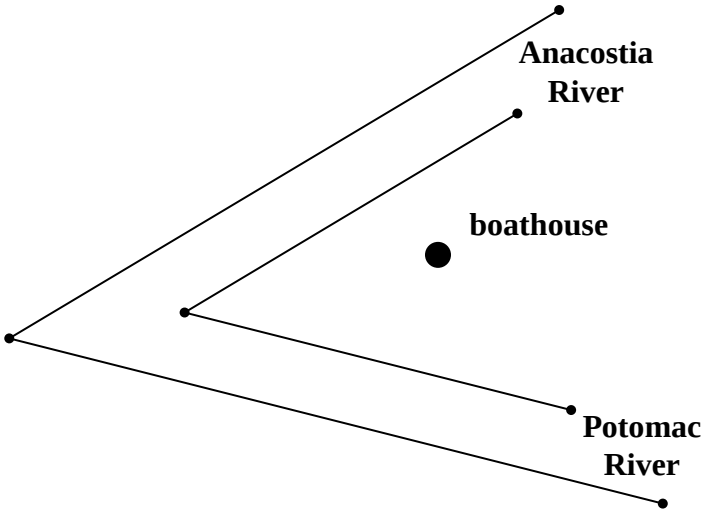


Atkinsons and Georgetown Hoyas Name: _____

Directions: Complete each construction using patty paper. Be sure to attach your patty paper to this worksheet with a stapler.

1. The Atkinsons are moving to a new town. They have two children. Bridget is in the fourth grade at the elementary school and Andrew is in the seventh grade at the middle school. Mr. and Mrs. Atkinson want to buy a house somewhere in the new town so that Bridget and Andrew have an equal distance to get to school. Where should the Atkinsons buy their new home? Use the points below to explain and justify your answer.

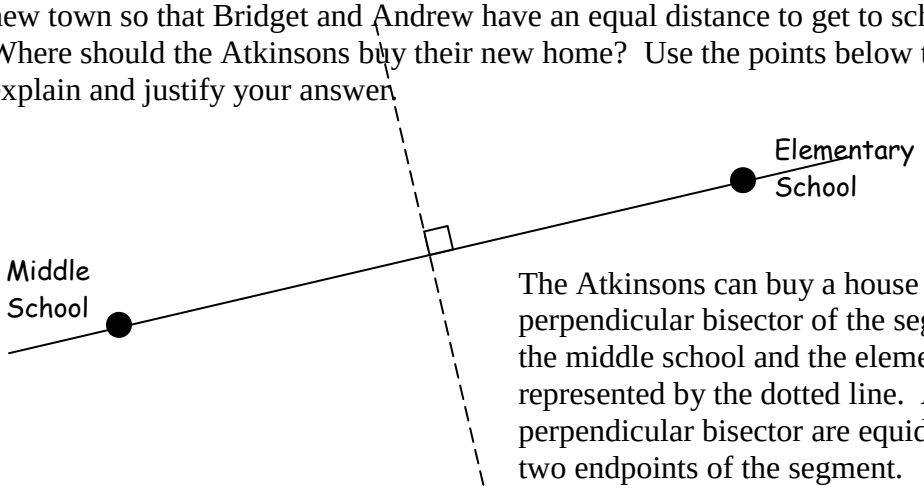
2. The Georgetown Hoyas Crew rowing team is looking for a place to put their boats into a river. Because the coach likes to make her team run to stay in shape, she wants to put the boats in the river that is farther from the boathouse. To which river should the Hoyas run? Use the diagram below to explain and justify your answer.



Atkinsons and Georgetown Hoyas Name: ___ANSWER KEY__

Directions: Complete each construction using patty paper. Be sure to attach your patty paper to this worksheet with a stapler.

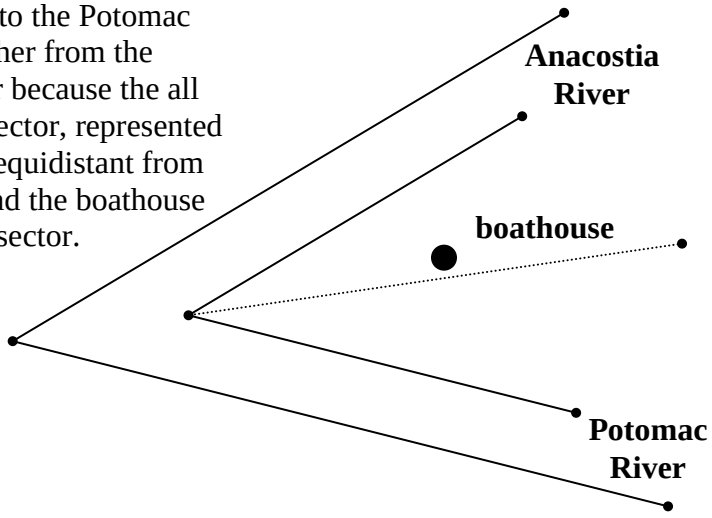
1. The Atkinsons are moving to a new town. They have two children. Bridget is in the fourth grade at the elementary school and Andrew is in the seventh grade at the middle school. Mr. and Mrs. Atkinson want to buy a house somewhere in the new town so that Bridget and Andrew have an equal distance to get to school. Where should the Atkinsons buy their new home? Use the points below to explain and justify your answer.



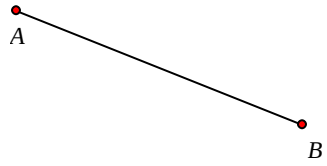
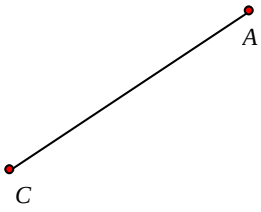
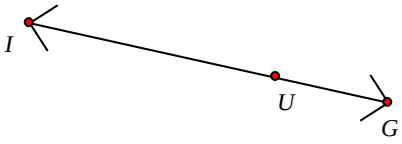
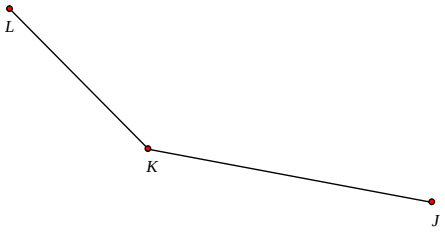
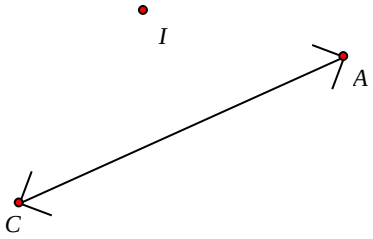
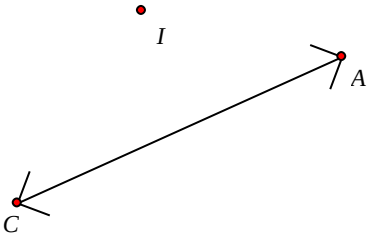
The Atkinsons can buy a house anywhere on the perpendicular bisector of the segment connecting the middle school and the elementary school, represented by the dotted line. All points on the perpendicular bisector are equidistant from the two endpoints of the segment.

2. The Georgetown Hoyas Crew rowing team is looking for a place to put their boats into a river. Because the coach likes to make her team run to stay in shape, she wants to put the boats in the river that is farther from the boathouse. To which river should the Hoyas run? Use the diagram below to explain and justify your answer.

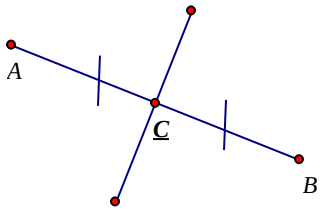
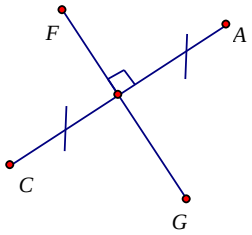
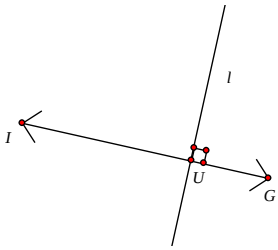
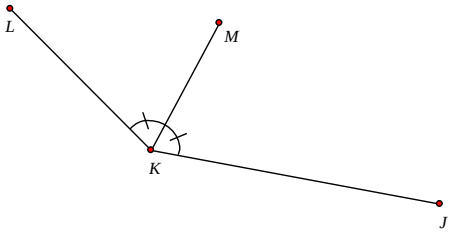
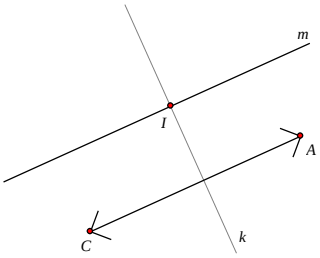
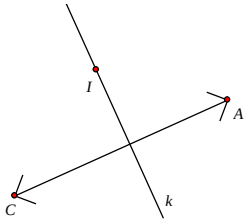
The Hoyas should run to the Potomac River because it is farther from the boathouse. It is farther because the all points on the angle bisector, represented by the dotted line, are equidistant from the rays of the angle and the boathouse is north of the angle bisector.



Isabel & Carl's Coach & Player Name: _____

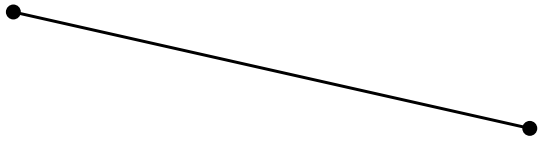
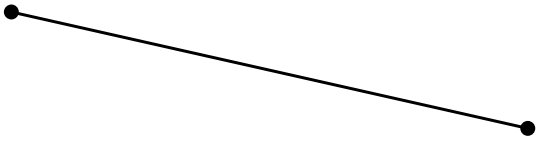
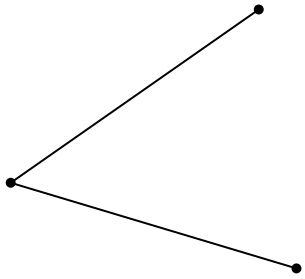
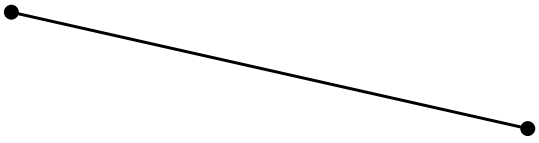
Constructor 1 Name_____	**Constructor 2 Name_____**
Construct the Midpoint. 	Construct the Perpendicular Bisector. 
Construct a line perpendicular to $\overleftrightarrow{IG}$ through point *U*. 	Construct the Angle Bisector. 
Construct a line parallel to $\overleftrightarrow{CA}$ through point *I*. 	Construct a line perpendicular to $\overleftrightarrow{CA}$ through point *I*. 

Isabel & Carl's Coach & Player Name: _ANSWER KEY____

Constructor 1 Name_____	**Constructor 2 Name_____**
Construct the Midpoint.  Point *C* is the midpoint.	Construct the Perpendicular Bisector.  $\overline{FG}$ is the perpendicular bisector of $\overline{AC}$
Construct a line perpendicular to $\overleftrightarrow{IG}$ through point *U*.  Line *l* is perpendicular to $\overleftrightarrow{IG}$.	Construct the Angle Bisector.  $\overline{KM}$ is an angle bisector of $\angle LKJ$
Construct a line parallel to $\overleftrightarrow{CA}$ through point *I*.  line $m // \overleftrightarrow{CA}$	Construct a line perpendicular to $\overleftrightarrow{CA}$ through point *I*.  line $k // \overleftrightarrow{CA}$

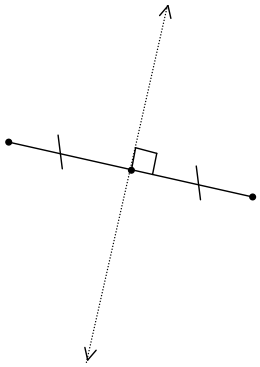
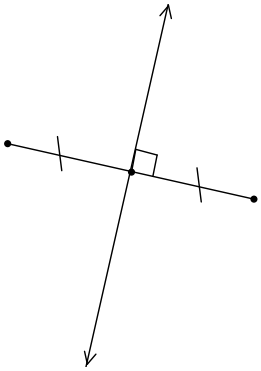
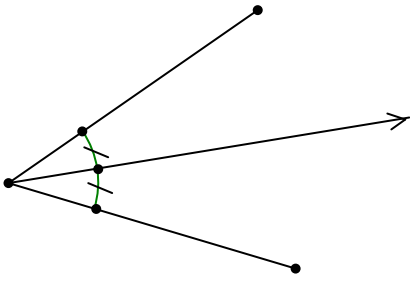
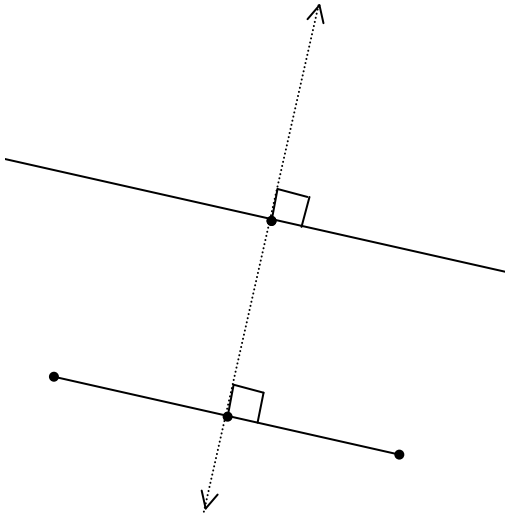
Assessment to Basic Constructions Name: _____

Isabel and Carl want to make sure that each of their constructors can produce the following constructions INDEPENDENTLY. Each construction should be done on a separate sheet of patty paper. Attach the sheets of patty paper when you are finished and turn it in to the teacher.

Midpoint	**Perpendicular Bisector**
	
Angle Bisector	**Parallel Lines**
	

Assessment to Basic Constructions Name: __ANSWER KEY___

Isabel and Carl want to make sure that each of their constructors can produce the following constructions INDEPENDENTLY. Each construction should be done on a separate sheet of patty paper. Attach the sheets of patty paper when you are finished and turn it in to the teacher.

Midpoint	**Perpendicular Bisector**
	
Angle Bisector	**Parallel Lines**
	

Isabel's Round Table
Acute

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an acute triangle. Label the vertices *A*, *C*, and *U*.	Copy and label triangle *ACU* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *A*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *C*. Written Explanation:	Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *U*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ACU* coincides with the triangle *ACU* below it. What do you observe about the three angle bisectors of triangle *ACU*? Write a conjecture.	
Conjecture:	

Isabel's Round Table
Right

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw a right triangle. Label the vertices *R*, *I*, and *G*.	Copy and label triangle *RIG* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *R*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *I*. Written Explanation:	Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *G*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *RIG* coincides with the triangle *RIG* below it. What do you observe about the three angle bisectors of triangle *RIG*? Write a conjecture.
Conjecture:

Isabel's Round Table
Obtuse

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an obtuse triangle. Label the vertices *O*, *B*, and *T*.	Copy and label triangle *OBT* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *O*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *B*. Written Explanation:	Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *T*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *OBT* coincides with the triangle *OBT* below it. What do you observe about the three angle bisectors of triangle *OBT*? Write a conjecture.
Conjecture:

Isabel's Round Table
Any

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw any triangle. Label the vertices *A*, *N*, and *Y*.	Copy and label triangle *ANY* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *A*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *N*. Written Explanation:	Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *Y*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ANY* coincides with the triangle *ANY* below it. What do you observe about the three angle bisectors of triangle *ANY*? Write a conjecture.
Conjecture:

Carl's Round Table
Acute

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an acute triangle. Label the vertices *A*, *C*, and *U*.	Copy and label triangle *ACU* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AC*... Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *CU*. Written Explanation:	Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AU*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle ACU coincides with the triangle ACU below it. What do you observe about the three perpendicular bisectors of triangle ACU? Write a conjecture.	

Conjecture:

Carl's Round Table
Right

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw a right triangle. Label the vertices *R*, *I*, and *G*.	Copy and label triangle *RIG* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *GR*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *GI*. Written Explanation:	Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *RI*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *RIG* coincides with the triangle *RIG* below it. What do you observe about the three perpendicular bisectors of triangle *RIG*? Write a conjecture.	

Conjecture:

Carl's Round Table
Obtuse

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an obtuse triangle. Label the vertices *O*, *B*, and *T*.	Copy and label triangle *OBT* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *OB*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *TO*. Written Explanation:	Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *TB*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *OBT* coincides with the triangle *OBT* below it. What do you observe about the three perpendicular bisectors of triangle *OBT*? Write a conjecture.	

Conjecture:

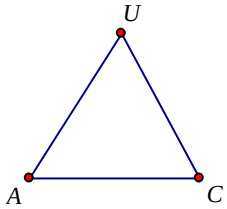
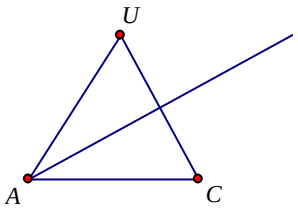
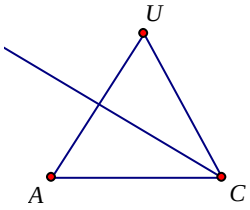
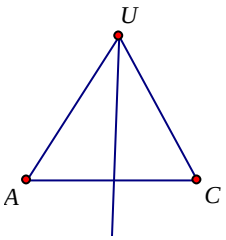
Carl's Round Table
Any

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw any triangle. Label the vertices *A*, *N*, and *Y*.	Copy and label triangle *ANY* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AN*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *NY*. Written Explanation:	Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AY*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ANY* coincides with the triangle *ANY* below it. What do you observe about the three perpendicular bisectors of triangle *ANY*? Write a conjecture.	

Conjecture:

Isabel's Round Table ANSWER KEY

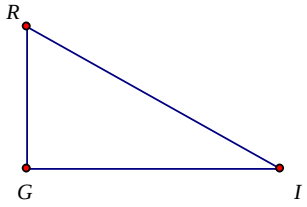
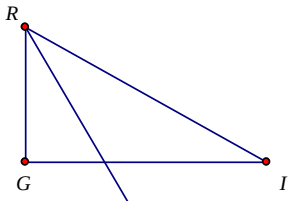
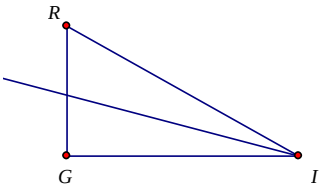
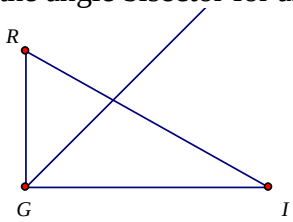
Acute

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an acute triangle. Label the vertices *A*, *C*, and *U*.  	Copy and label triangle *ACU* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *A*.  Written Explanation: Fold the patty paper through pt *A* so that ray *AU* and ray *AC* coincide. Crease patty paper to construct the angle bisector for angle *A*.
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *C*.  Written Explanation: Fold the patty paper through pt *C* so that ray *CA* and ray *CU* coincide. Crease patty paper to construct the angle bisector for angle *C*.	Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *U*.  Written Explanation: Fold the patty paper through pt *U* so that ray *UC* and ray *UA* coincide. Crease patty paper to construct the angle bisector for angle *U*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ACU* coincides with the triangle *ACU* below it. What do you observe about the three angle bisectors of triangle *ACU*? Write a conjecture.
Conjecture: The three angle bisectors of triangle *ACU* all intersect at the same point. (This point of concurrency is called the incenter. **I**sabel **I**guana–**I**ncenter.

Isabel's Round Table ANSWER KEY

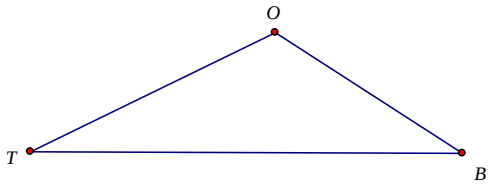
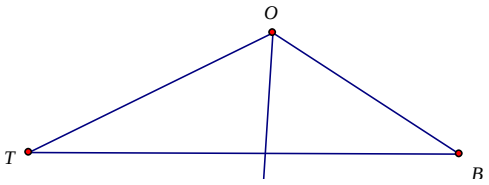
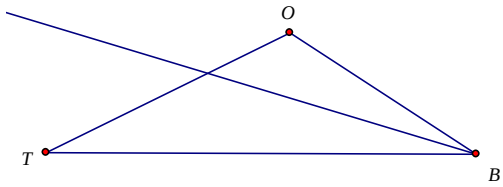
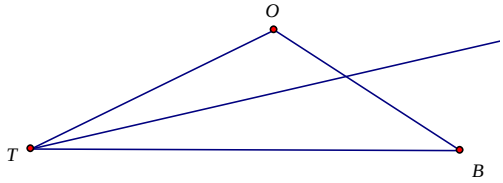
Right

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw a right triangle. Label the vertices *R*, *I*, and *G*.  	Copy and label triangle *RIG* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *R*.  Written Explanation: Fold the patty paper through pt *R* so that ray *RI* and ray *RG* coincide. Crease patty paper to construct the angle bisector for angle *R*.
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *I*.  Written Explanation: Fold the patty paper through pt I so that ray *IR* and ray *IG* coincide. Crease patty paper to construct the angle bisector for angle *I*.	Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *G*.  Written Explanation: Fold the patty paper through pt *G* so that ray *GR* and ray *GI* coincide. Crease patty paper to construct the angle bisector for angle *G*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *RIG* coincides with the triangle *RIG* below it. What do you observe about the three angle bisectors of triangle *RIG*? Write a conjecture.
Conjecture: The three angle bisectors of triangle RIG all intersect at the same point. (This point of concurrency is called the incenter. **I**sabel **I**guana–**I**ncenter.

Isabel's Round Table ANSWER KEY

Obtuse

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an obtuse triangle. Label the vertices *O*, *B*, and *T*.  	Copy and label triangle *OBT* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *O*.  Written Explanation: Fold the patty paper through pt *O* so that ray *OB* and ray *OT* coincide. Crease patty paper to construct the angle bisector for angle *O*.
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *B*.  Written Explanation: Fold the patty paper through pt *B* so that ray *BO* and ray *BT* coincide. Crease patty paper to construct the angle bisector for angle *B*.	Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *T*.  Written Explanation: Fold the patty paper through pt *T* so that ray *TO* and ray *TB* coincide. Crease patty paper to construct the angle bisector for angle *T*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *OBT* coincides with the triangle *OBT* below it. What do you observe about the three angle bisectors of triangle *OBT*? Write a conjecture.
Conjecture: The three angle bisectors of triangle *OBT* all intersect at the same point. (This point of concurrency is called the incenter. **I**sabel **I**guana–**I**ncenter.

Isabel's Round Table ANSWER KEY

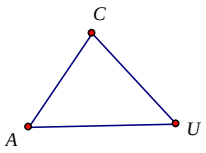
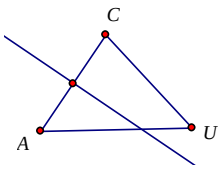
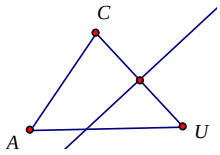
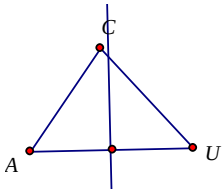
Any

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw any triangle. Label the vertices *A*, *N*, and *Y*. **See student responses. Constructor 1 may choice an acute, right or obtuse triangle. See the examples from above for possible solutions.**	Copy and label triangle *ANY* onto a sheet of patty paper. Use the patty paper to construct the angle bisector for angle *A*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *N*. Written Explanation:	Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the angle bisector for angle *Y*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**

Constructor 1:
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ANY* coincides with the triangle *ANY* below it. What do you observe about the three angle bisectors of triangle *ANY*? Write a conjecture.
Conjecture:

Carl's Round Table ANSWER KEY

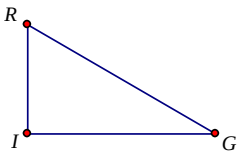
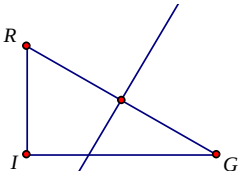
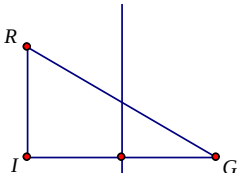
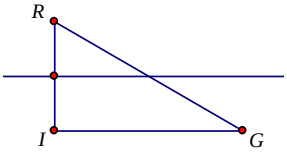
Acute

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an acute triangle. Label the vertices *A*, *C*, and *U*. 	Copy and label triangle *ACU* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AC*...  Written Explanation: Fold the patty paper through segment *AC* so that point *A* and point *C* coincide. Crease patty paper to construct the perpendicular bisector for side *AC*
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *CU*.  Written Explanation: Fold the patty paper through segment *CU* so that point *C* and point *U* coincide. Crease patty paper to construct the perpendicular bisector for side *CU*.	Copy and label triangle *ACU* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AU*.  Written Explanation: Fold the patty paper through segment *AU* so that point *A* and point *U* coincide. Crease patty paper to construct the perpendicular bisector for side *AU*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	

In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle ACU coincides with the triangle ACU below it. What do you observe about the three perpendicular bisectors of triangle ACU? Write a conjecture.
Conjecture: The three perpendicular bisectors of triangle *ACU* all intersect at the same point. (This point of concurrency is called the circumcenter. **C**arl–**C**aterpillar–**C**ircumcenter.

Carl's Round Table ANSWER KEY

Right

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw a right triangle. Label the vertices *R*, *I*, and *G*.  	Copy and label triangle *RIG* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *GR*.  Written Explanation: Fold the patty paper through segment *GR* so that point *G* and point *R* coincide. Crease patty paper to construct the perpendicular bisector for side *GR*.
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *GI*.  Written Explanation: Fold the patty paper through segment *GI* so that point *G* and point *I* coincide. Crease patty paper to construct the perpendicular bisector for side *GI*.	Copy and label triangle *RIG* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *RI*.  Written Explanation: Fold the patty paper through segment *RI* so that point *R* and point *I* coincide. Crease patty paper to construct the perpendicular bisector for side *RI*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	

In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *RIG* coincides with the triangle *RIG* below it. What do you observe about the three perpendicular bisectors of triangle *RIG*? Write a conjecture.
Conjecture: The three perpendicular bisectors of triangle *RIG* all intersect at the same point. (This point of concurrency is called the circumcenter. **C**arl–**C**aterpillar–**C**ircumcenter.

Carl's Round Table ANSWER KEY
Obtuse

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw an obtuse triangle. Label the vertices *O*, *B*, and *T*.	Copy and label triangle *OBT* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *OB*. Written Explanation: Fold the patty paper through segment *OB* so that point *O* and point *B* coincide. Crease patty paper to construct the perpendicular bisector for side *OB*.
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *TO*. Written Explanation: Fold the patty paper through segment *TO* so that point *T* and point *O* coincide. Crease patty paper to construct the perpendicular bisector for side *TO*.	Copy and label triangle *OBT* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *TB*. Written Explanation: Fold the patty paper through segment *TB* so that point *T* and point *B* coincide. Crease patty paper to construct the perpendicular bisector for side *TB*.
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *OBT* coincides with the triangle *OBT* below it. What do you observe about the three perpendicular bisectors of triangle *OBT*? Write a conjecture.	

Conjecture:
The three perpendicular bisectors of triangle *OBT* all intersect at the same point. (This point of concurrency is called the circumcenter.
Carl–**C**aterpillar–**C**ircumcenter.

Carl's Round Table ANSWER KEY

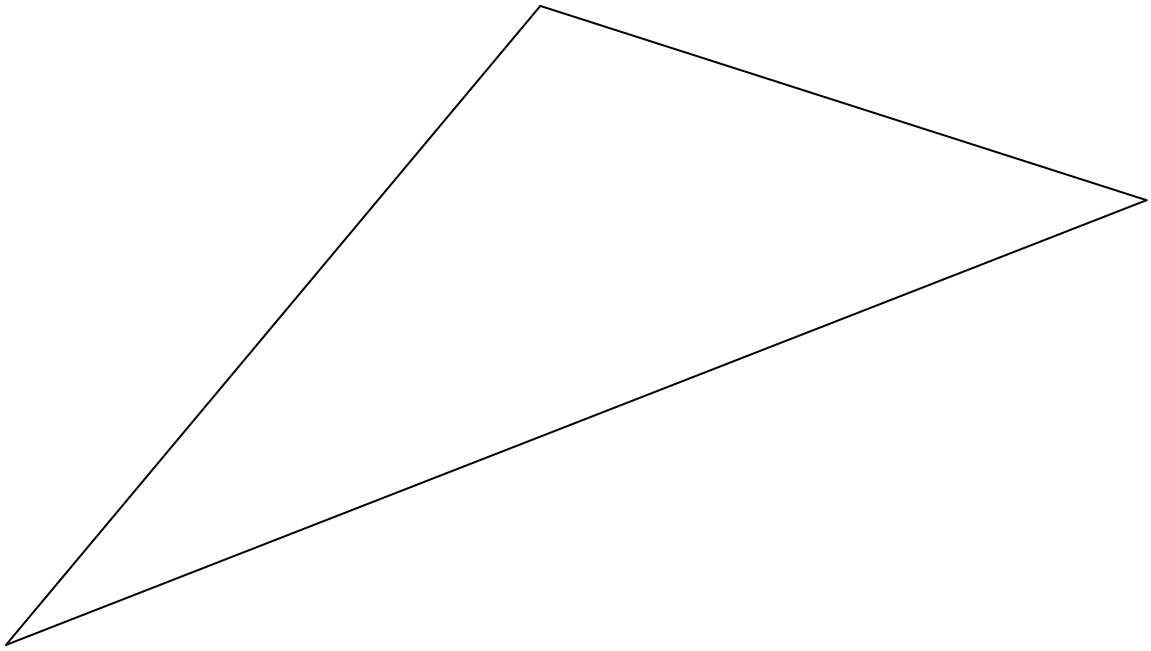
Any

Constructor 1:	**Constructor 2:**
In the space provided, use a straight edge to draw any triangle. Label the vertices *A*, *N*, and *Y*. **See student responses. Constructor 1 may choice an acute, right or obtuse triangle. See the examples from above for possible solutions.**	Copy and label triangle *ANY* onto a sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AN*. Written Explanation:
Constructor 2's Initials_____	**Constructor 3's Initials_____**
Constructor 3:	**Constructor 4:**
Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *NY*. Written Explanation:	Copy and label triangle *ANY* onto another sheet of patty paper. Use the patty paper to construct the perpendicular bisector for side *AY*. Written Explanation:
Constructor 4's Initials_____	**Constructor 1's Initials_____**
Constructor 1:	
In box 1, attach all 3 sheets of patty paper on top of each other so that each triangle *ANY* coincides with the triangle *ANY* below it. What do you observe about the three perpendicular bisectors of triangle *ANY*? Write a conjecture.	

Conjecture:

Boss/Secretary Incenter Name: _____

- Construct the incenter in the triangle.



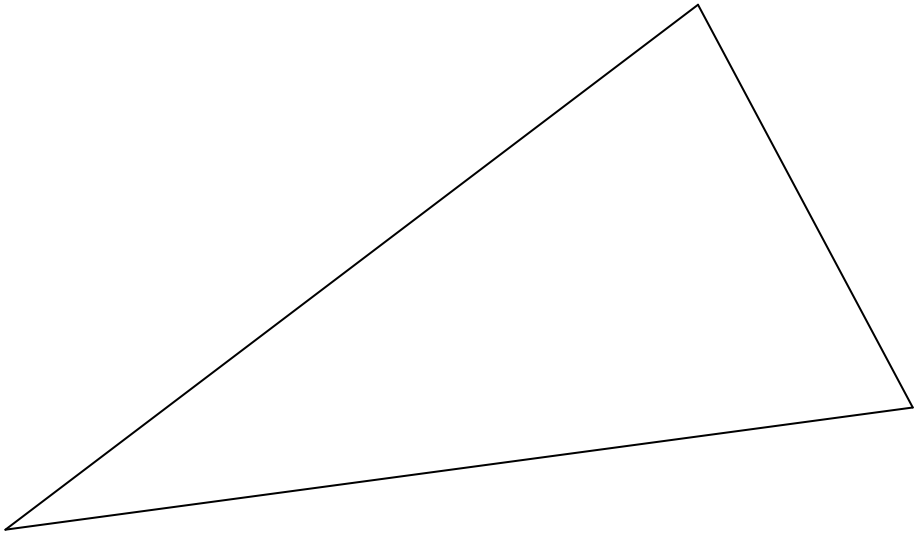
- The incenter is equidistant to the 3 _____.

- Use your compass to justify your response.

- Do you think the incenter is always on the inside of the triangle?

Boss/Secretary Circumcenter Name: _____

- Construct the circumcenter in the triangle.



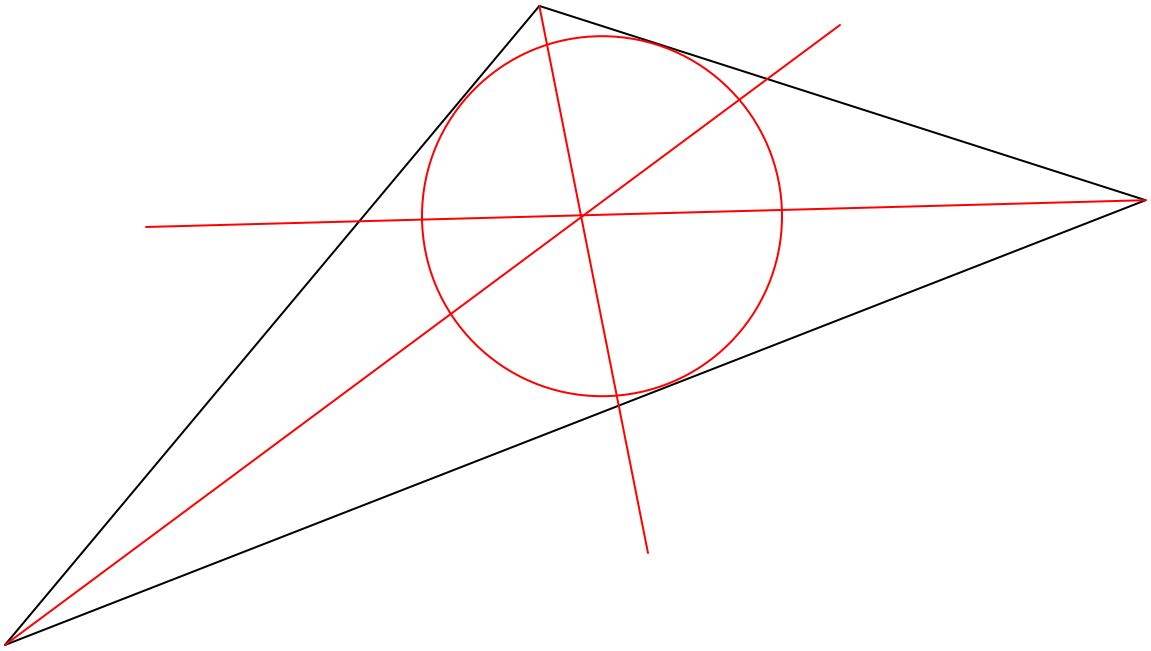
- The circumcenter is equidistant to the 3 _____.

- Use your compass to justify your response.

- Do you think the circumcenter is always on the inside of the triangle?

Boss/Secretary Incenter Name: _____ANSWER KEY_____

- Construct the incenter in the triangle.



- The incenter is equidistant to the 3 ___sides of the triangle._____.

- Use your compass to justify your response.

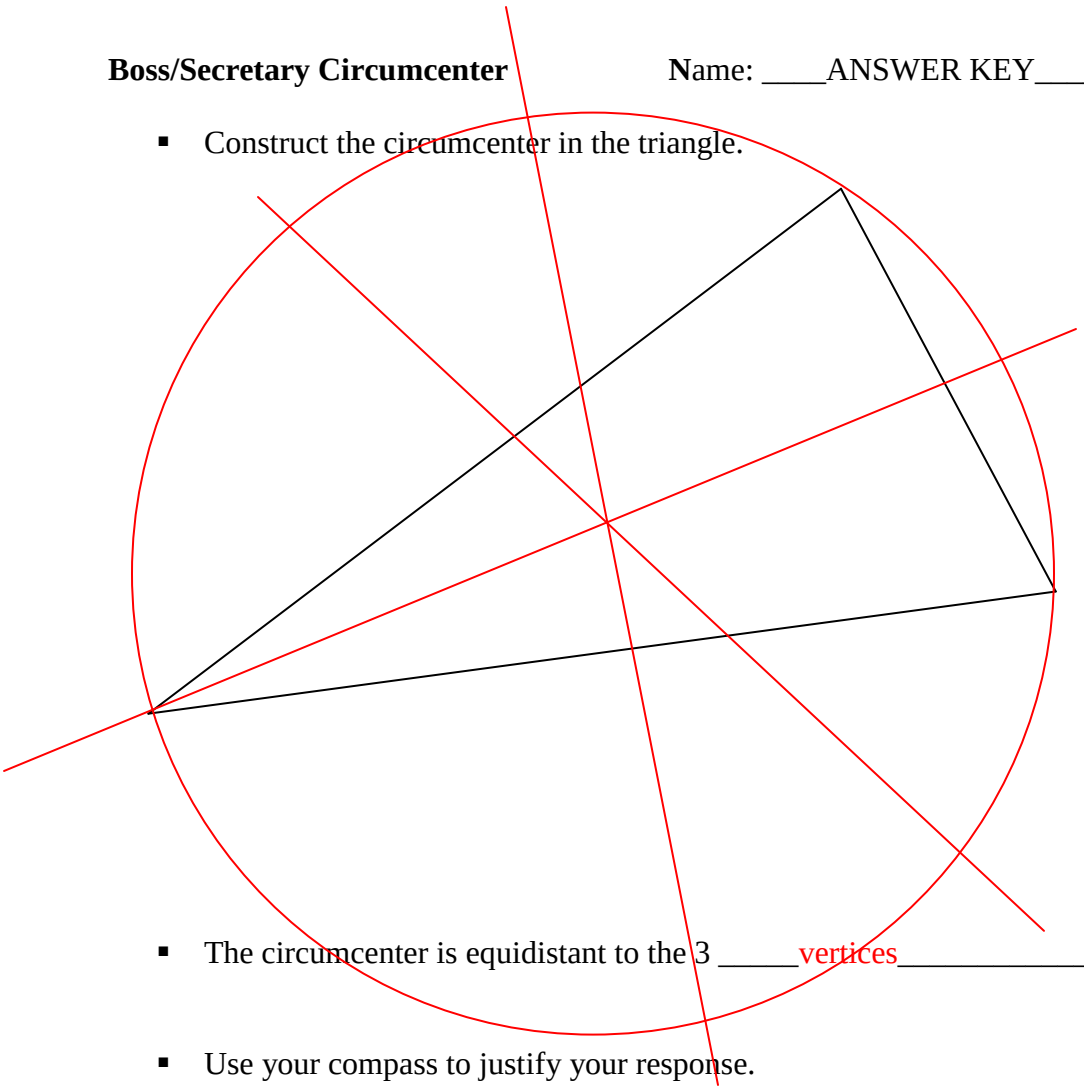
  Since the incenter is equidistant to the three sides of a triangle, it is the center of the inscribed circle. The center of the inscribed circle [incenter] is the intersection of the three angle bisectors of a triangle, and the inscribed circle intersects each side of the triangle only once.)

- Do you think the incenter is always on the inside of the triangle?
-

  The incenter is ALWAYS inside the triangle.

Boss/Secretary Circumcenter **N**ame: ____ANSWER KEY_____

- Construct the circumcenter in the triangle.



- The circumcenter is equidistant to the 3 _____vertices_____.

- Use your compass to justify your response.

  Since the circumcenter is equidistant to the three vertices [points] of a triangle, it is the center of the circumscribed circle. The center of the circumscribed circle [circumcenter] is the intersection of the three perpendicular bisectors of a triangle, and the circumscribed circle intersects each vertex of the triangle.)

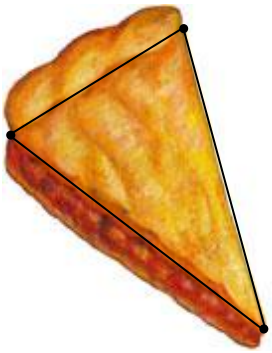
- Do you think the circumcenter is always on the inside of the triangle?

- The circumcenter is located inside an acute triangle, outside of an obtuse triangle, and is the midpoint of the hypotenuse of a right triangle.

Applications of Incenter and Circumcenter Name: _____

Isabel and Carl need to help their friends construct the point described.

1. Sarah the Salamander wants to place the largest, circular dollop of whipped cream on a piece of pie without any whipped cream falling off the edges. Sarah needs Isabel's and Carl's help to determine where to place the whipped cream. Justify your answer.



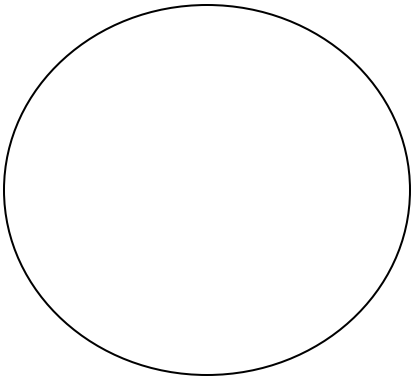
2. Buddy the Bee wants to place an island countertop in his kitchen. Buddy wants to the island to be equidistant from the oven, refrigerator and sink. Buddy needs Isabel's and Carl's help to determine where to place the island. Justify your answer.

Oven

Refrigerator

Sink

3. Gary the Grasshopper wants to build his home in the center of a circular park. Gary needs Isabel's and Carl's help to determine where to build his home. Justify your answer.

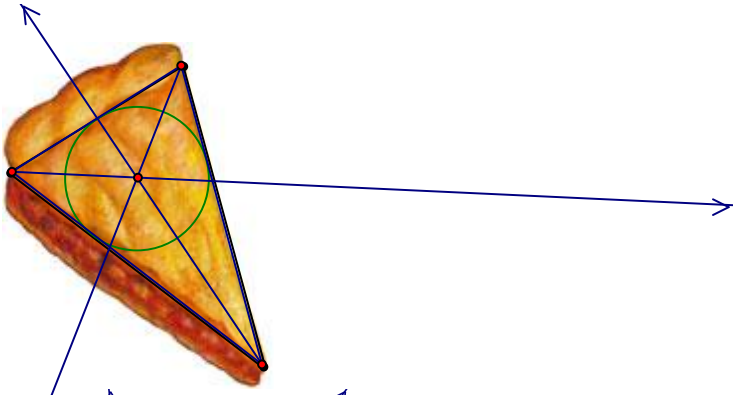


Applications of Incenter and Circumcenter Name: _____

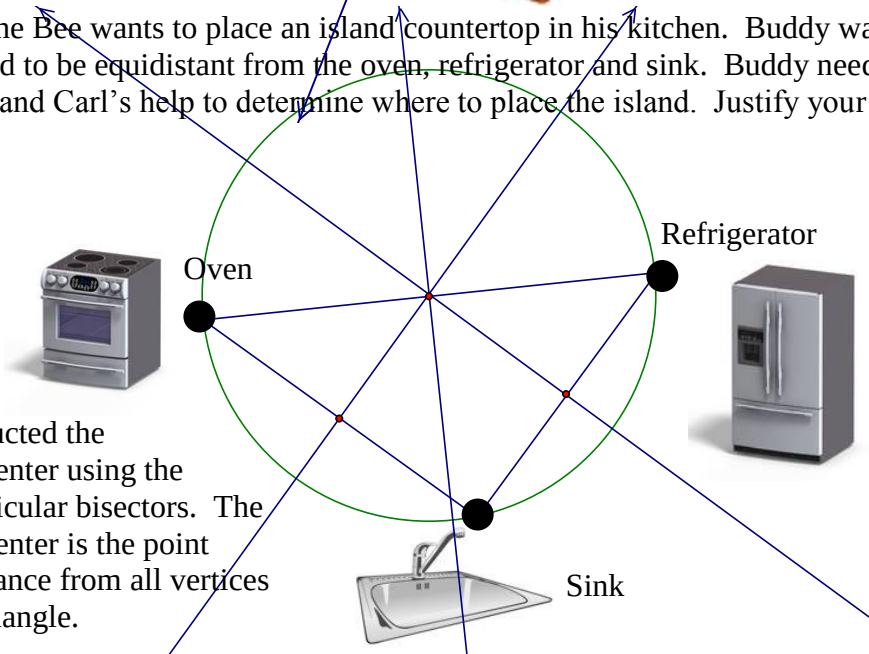
Isabel and Carl need to help their friends construct the point described.

1. Sarah the Salamander wants to place the largest, circular dollop of whipped cream on a piece of pie without any whipped cream falling off the edges. Sarah needs Isabel's and Carl's help to determine where to place the whipped cream. Justify your answer.

   I constructed the incenter using the angle bisectors of the triangle. The incenter is the point equidistant from all the sides. The constructed circle represents where the whipped cream will be placed.



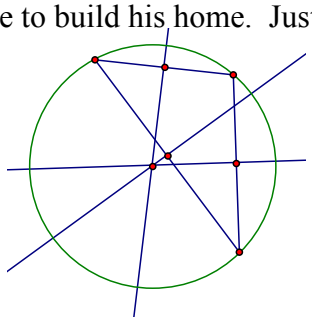
2. Buddy the Bee wants to place an island countertop in his kitchen. Buddy wants to the island to be equidistant from the oven, refrigerator and sink. Buddy needs Isabel's and Carl's help to determine where to place the island. Justify your answer.



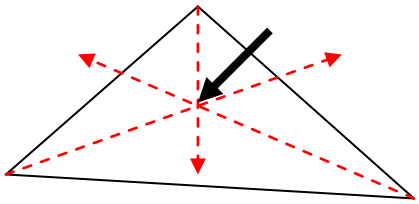
   I constructed the circumcenter using the perpendicular bisectors. The circumcenter is the point equidistance from all vertices of the triangle.

3. Gary the Grasshopper wants to build his home in the center of a circular park. Gary needs Isabel's and Carl's help to determine where to build his home. Justify your answer.

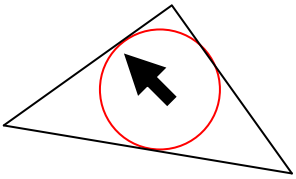
   I inscribed a triangle in the circle and constructed the perpendicular bisectors. This formed the circumcenter which is the center of the circle.



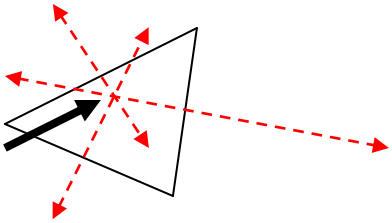
incenter



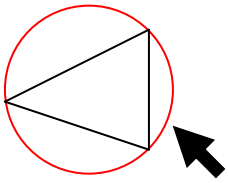
inscribed circle



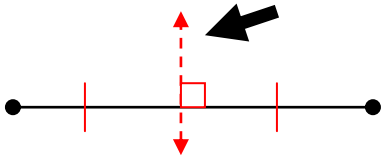
circumcenter



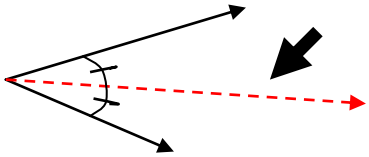
circumscribed circle



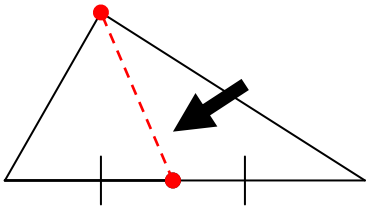
perpendicular bisector



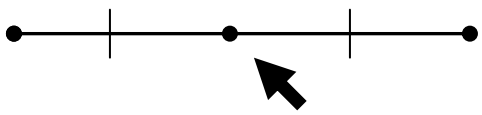
angle bisector



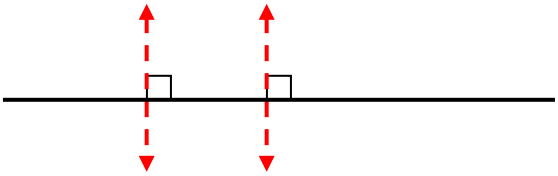
median



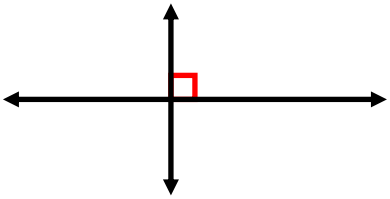
midpoint



parallel lines



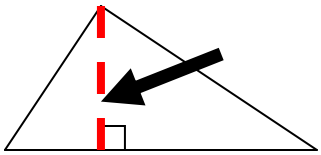
perpendicular lines



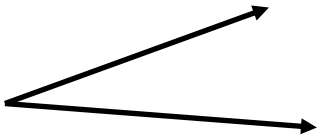
corner of a sheet of patty paper

right angle OR 90 degree angle

altitude



angle



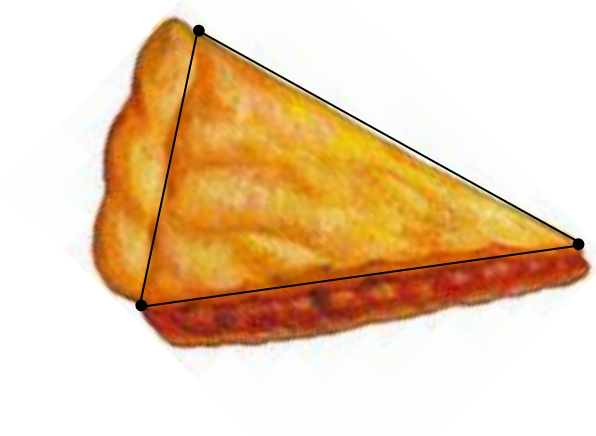
segment

Group Members	

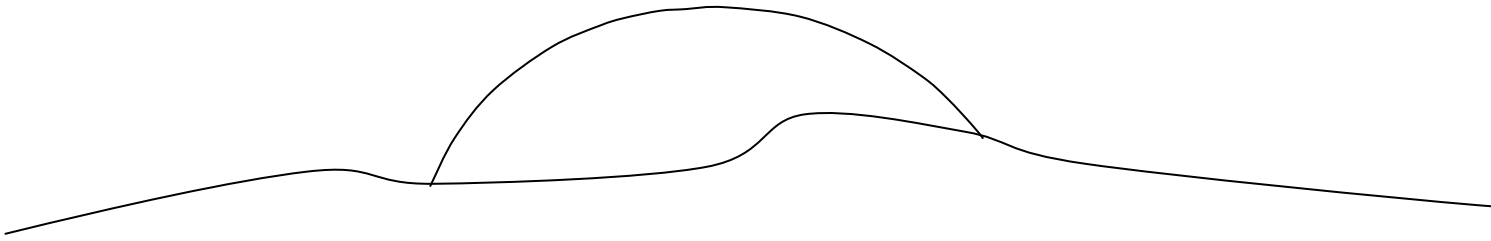
Directions:

- Each student must write his/her name on his/her own sheet of patty paper, copy the picture onto patty paper and perform the construction.
- As a group, decide which patty paper will be graded and staple it on top for each question. The remaining patty paper constructions should be grouped together and stapled to the *back* of the paper.
- The group will be graded on four out of the five problems. The pieces of patty paper stapled to the top of the worksheet will signify which problems the teacher will grade.

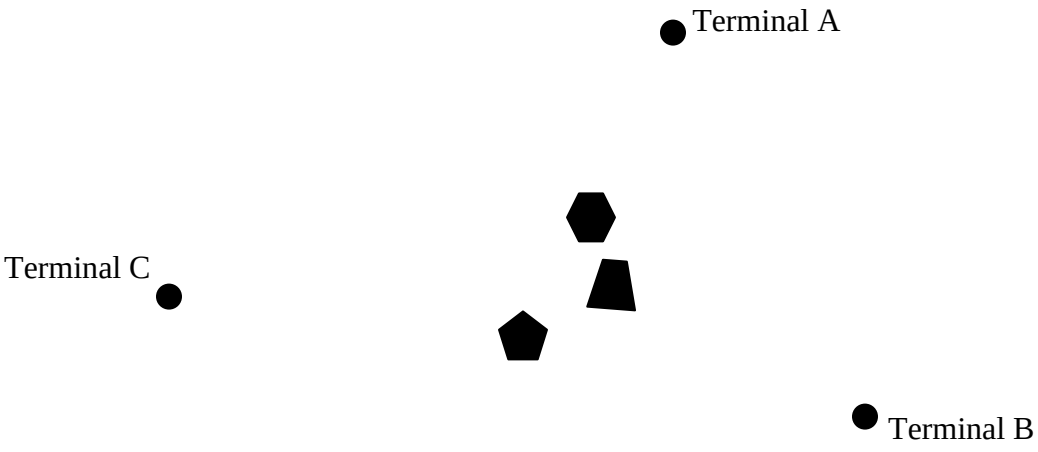
1. Sarah wants to place the largest, circular scoop of ice cream on her piece of apple pie without any ice cream falling off the edges. Where should Sarah place the ice cream? Show your construction and use mathematics to justify your response with words, symbols, or both.



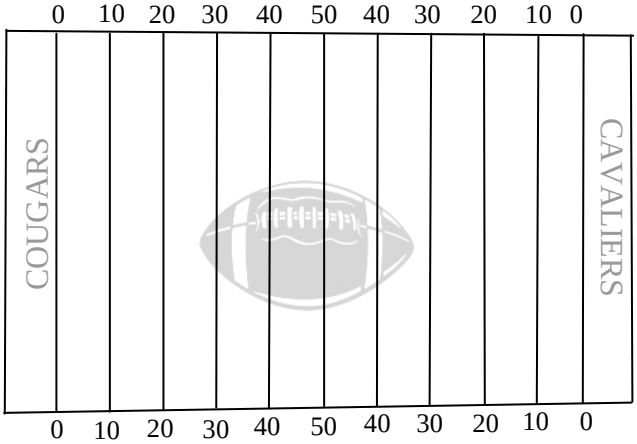
2. Michael has found a circular plate partially buried in the sand. Because Michael doesn't know the size of the plate, he wants to first find the center of it, and then he will decide whether it is worth it to continue digging. How can Michael find the center of the circle? Show your construction and use mathematics to justify your response with words, symbols, or both.



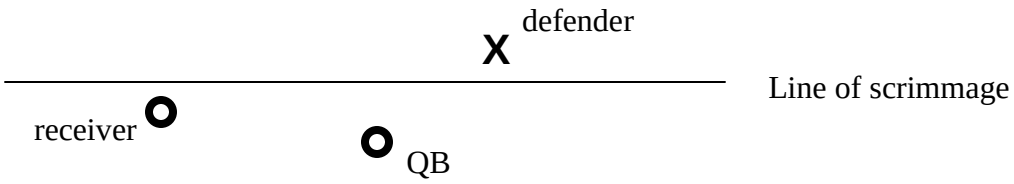
3. You flew into Dulles Airport, but you don't know where to pick up your luggage. One flight attendant told you that your luggage will be near the Trapezoid Tea Stand, Pentagon Parlor, or Hexagon Hair Salon. Another flight attendant told you that your luggage would be equidistant from Terminal A, Terminal B, and Terminal C. Assuming both people are correct, where is your luggage? Use the diagram below to determine where your luggage is. Show your construction and use mathematics to justify your response with words, symbols, or both.



4. Colleen is painting the lines on a football field (the pictures are not drawn to scale). Are the two **side line**s parallel? Why is it important that the lines are parallel? Show your construction and use mathematics to justify your response with words, symbols, or both.



5. The Mighty Cavaliers are on the football field, ready to make a great play. The players line up on the line of scrimmage, the quarterback (QB) calls for the ball, and he launches it down the field. The receiver and the defender take off, hoping to get to the ball first. They both have to run the same distance to get the ball. Use constructions on the diagram below to show the possible places where the ball was headed. Justify your answer using words, symbols or both.



Group Members	ANSWER KEY

Directions:

- Each student must write his/her name on his/her own sheet of patty paper, copy the picture onto patty paper and perform the construction.
- As a group, decide which patty paper will be graded and staple it on top for each question. The remaining patty paper constructions should be grouped together and stapled to the *back* of the paper.
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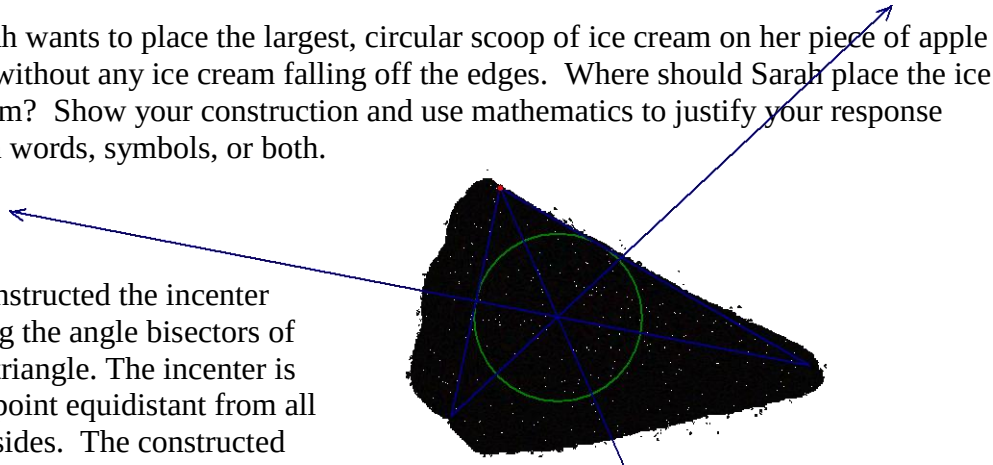
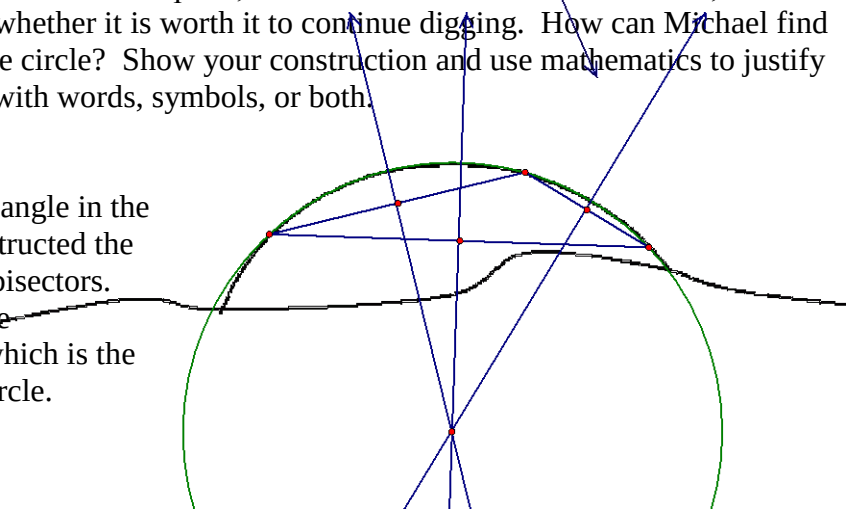
1. Sarah wants to place the largest, circular scoop of ice cream on her piece of apple pie without any ice cream falling off the edges. Where should Sarah place the ice cream? Show your construction and use mathematics to justify your response with words, symbols, or both.



I constructed the incenter using the angle bisectors of the triangle. The incenter is the point equidistant from all the sides. The constructed circle represents where the ice cream will be placed.

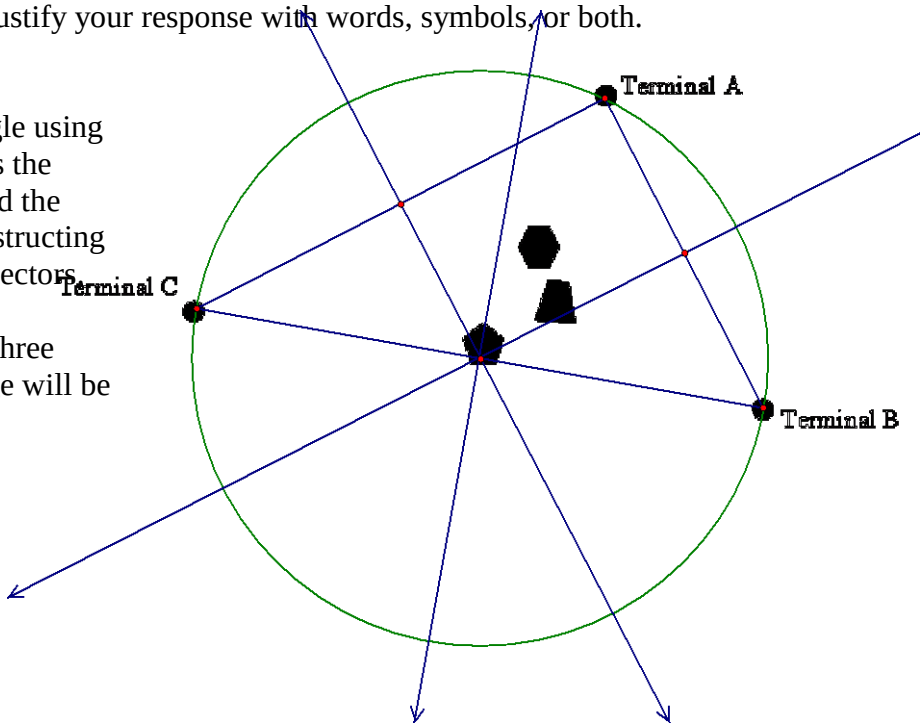
2. Michael has found a circular plate partially buried in the sand. Because Michael doesn't know the size of the plate, he wants to first find the center of it, and then he will decide whether it is worth it to continue digging. How can Michael find the center of the circle? Show your construction and use mathematics to justify your response with words, symbols, or both.



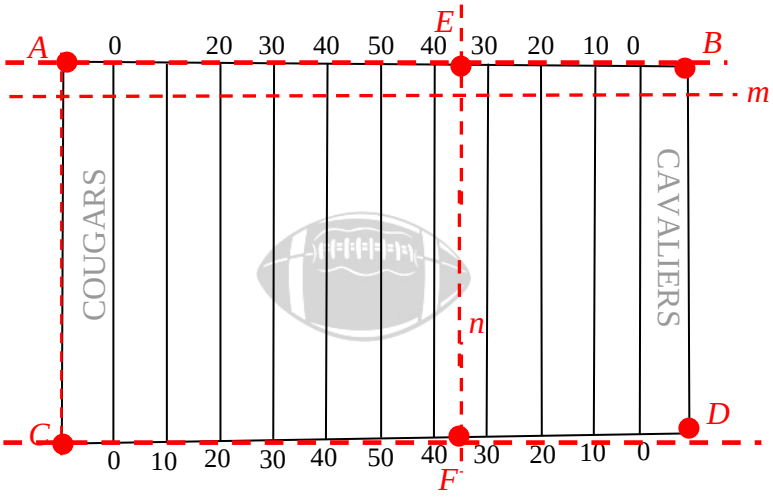
I inscribed a triangle in the circle and constructed the perpendicular bisectors. This formed the circumcenter which is the center of the circle.

3. You flew into Dulles Airport, but you don't know where to pick up your luggage. One flight attendant told you that your luggage will be near the Trapezoid Tea Stand, Pentagon Parlor, or Hexagon Hair Salon. Another flight attendant told you that your luggage would be equidistant from Terminal A, Terminal B, and Terminal C. Assuming both people are correct, where is your luggage? Use the diagram below to determine where your luggage is. Show your construction and use mathematics to justify your response with words, symbols, or both.

I constructed a triangle using the three terminals as the vertices. I constructed the circumcenter by constructing the perpendicular bisectors. The circumcenter is equidistant from all three vertices. The luggage will be at Pentagon Parlor.

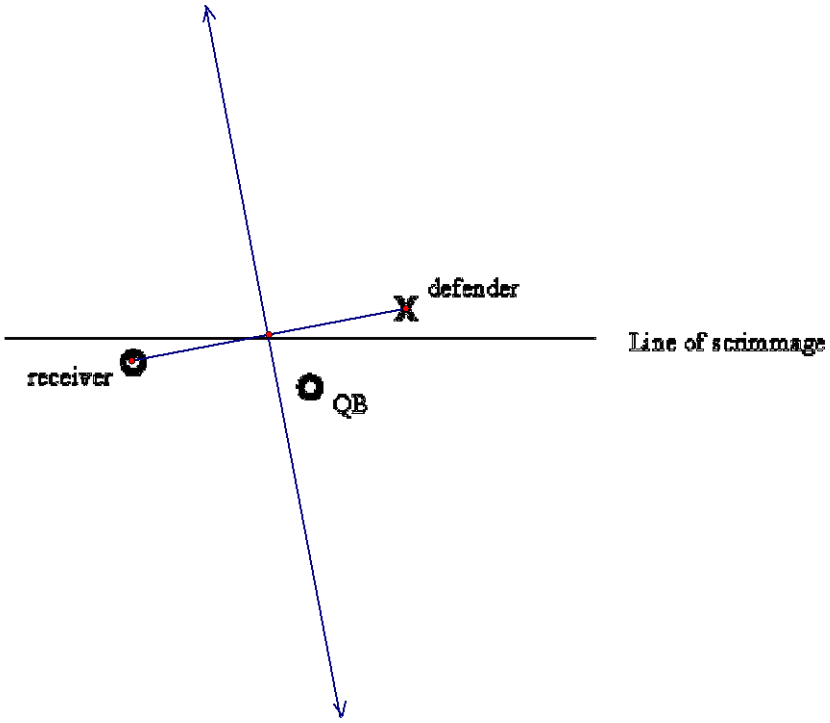


4. Colleen is painting the lines on a football field (the picture is not drawn to scale). Are the two **side line**s parallel? Why is it important that the lines are parallel? Show your construction and use mathematics to justify your response with words, symbols, or both.



I inserted four points on the corner to make the justification easier to follow. I know that two lines perpendicular to the same line are parallel. Therefore I will construct two lines that are both perpendicular to the same line. To determine if the two side lines are parallel, pick one end line (I chose AC) and construct a perpendicular line through this line. Call this new line, m. Now, draw point E on one of the side lines (I chose AB) and construct a line perpendicular to line m through point E. Call this line n. Now construct two lines (one through point E and one through point F) perpendicular to line n (These two lines should be the side lines of the diagram). Lay the patty paper on top of the diagram and notice that the two side lines do not match up with side lines in the diagram. Therefore the side lines are not parallel. It is important to have parallel side lines so that both end zones are congruent, which would ensure fair opportunity for touchdowns.

5. The Mighty Cavaliers are on the football field, ready to make a great play. The players line up on the line of scrimmage, the quarterback (QB) calls for the ball, and he launches it down the field. The receiver and the defender take off, hoping to get to the ball first. They both have to run the same distance to get the ball. Use constructions on the diagram below to show the possible places where the ball was headed. Justify your answer using words, symbols or both.



I connected the 'receiver' to the 'defender' with a line segment. I then constructed the perpendicular bisector to that segment because every point on the perpendicular bisector is equidistant to the endpoints of the bisected segment. The perpendicular bisector represents the path of the football.